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ELECTRIC POWER FOR ALCOHOL MAKING

PLANT OF THE CORNING DISTILLING CO., PEORIA, ILL.

IN the pages of romance alcohol making figures as located in the heart of the Kentucky or Tennessee mountains, in some rocky, inaccessible spot, where, with a fire of logs and a crude still, the mountaineer prepares his daily beverage every night; but while the still is the main thing in the process, in the prosaic modern method of manufacture it needs a tremendous auxiliary equipment of grinding, stirring and pumping machinery, great buildings for storage, and everywhere the necessary electric light to avoid danger from fire.

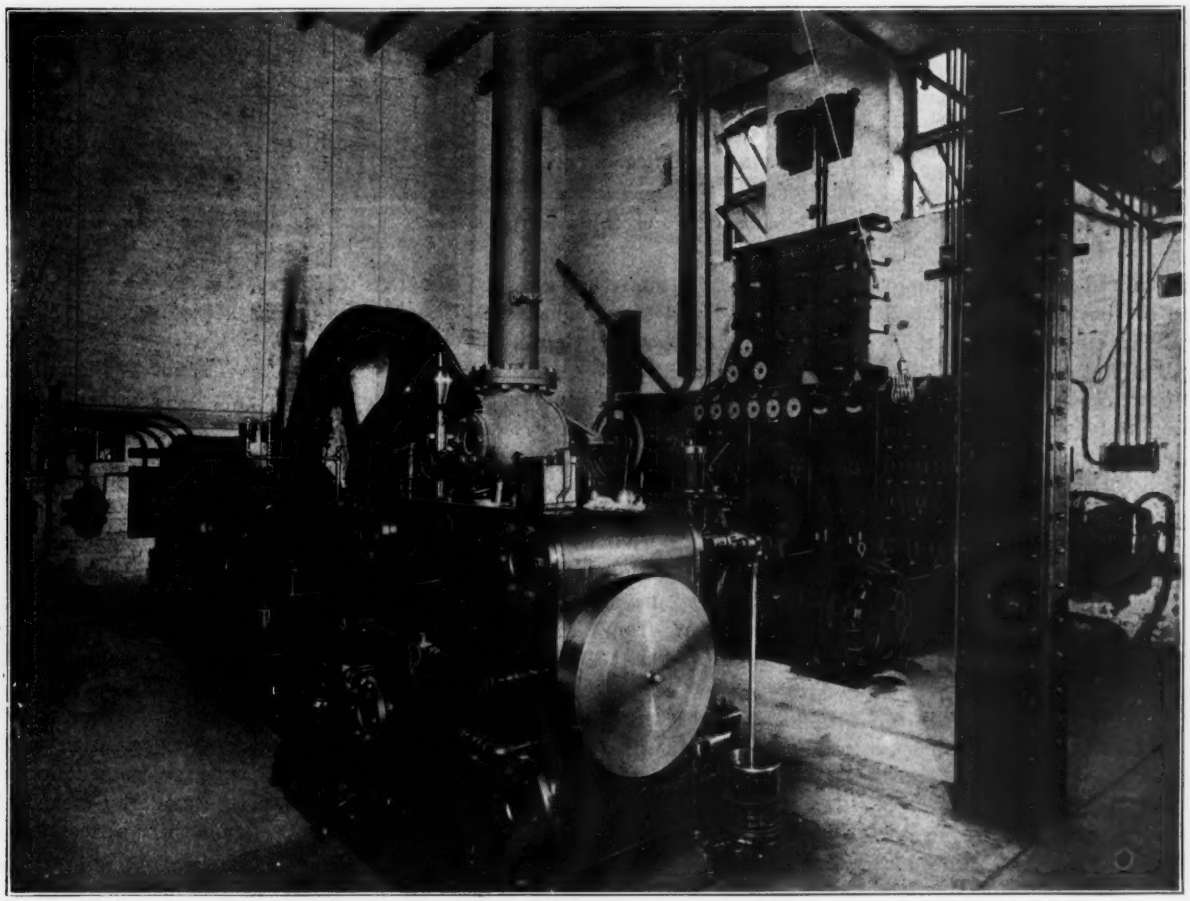


FIG. 2. VIEW IN ENGINE ROOM SHOWING 22 BY 42-IN. MURRAY CORLISS ENGINE, MOTOR-DRIVEN EXCITER AND SWITCHBOARD

The necessity for the greatest possible care in the prevention of fire has been shown in this very plant twice since its establishment in 1901. Once a warehouse collapsed, the contents catching fire and running, a blazing stream, across the street to the sheds where the cattle were kept, destroying over 3,000 head and resulting in the injury of several persons. Again, on the 3d of April, 1908, fire caught in the mill building, which contained the power plant and most of the power machinery, and in 4 hr. consumed the grain elevators and storage, the mill and engine room, and completely tied up the plant. Strangely enough, while the fire was hot enough to melt the brass work on the 2 engines, it did not work its way into the alcohol tower, in which it would have found thousands of gallons of liquor to increase its fierceness; nor did it manage to jump into the boiler house, although this was separated only by a 6-ft. passage from the engine

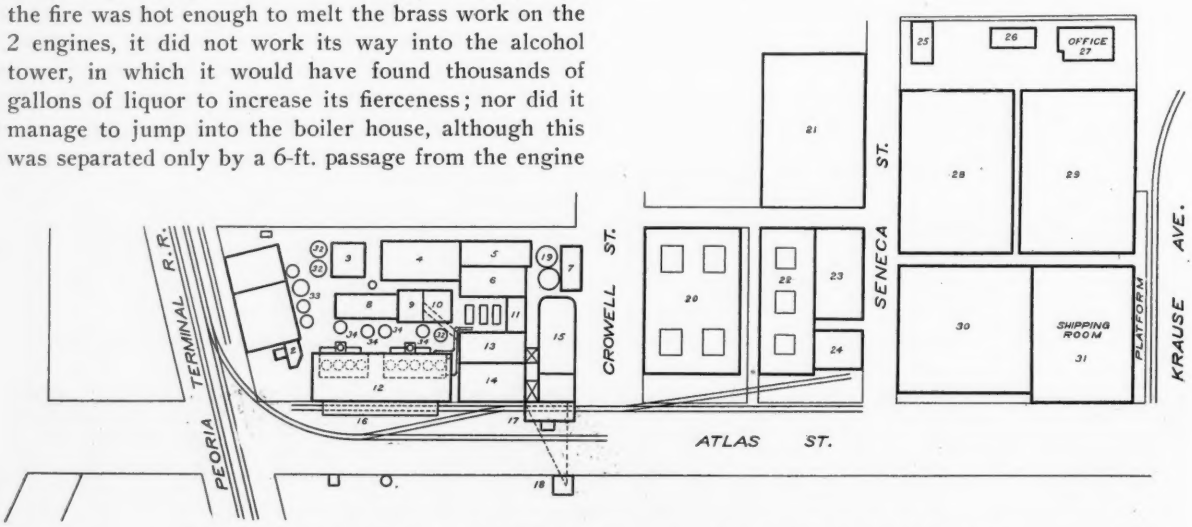


FIG. 1. PLAN OF BUILDING ARRANGEMENT AT CORNING DISTILLING CO.'S PLANT

2. FEED HOUSE ENGINE ROOM. 3. GIN HOUSE. 4. STORAGE AND RECTIFYING HOUSE. 5. STILL ROOM. 6. ALCOHOL STILL TOWER. 7. BEER VATS. 8. YEAST HOUSE. 10. PUMP HOUSE. 11. BEER STILL TOWER. 12. BOILER HOUSE. 13. COOKERS AND ENGINE ROOM. 14. MILL BUILDING. 15. ELEVATOR. 19. MASH TANKS. 20 AND 22. FERMENTING HOUSES. 23 AND 24. BOTTLING DEPARTMENT. 21, 28, 29 AND 30. WAREHOUSES. 33. SLOP TUBS. 34. WATER TANKS.

room and mill, and the upper part of the boiler house is of sheet iron and wood construction. The lesson was carefully heeded in the reconstruction of the power plant and elevator, and they have been made without a particle of wood anywhere; even the window cases and frames are all metal and all stairways and other parts of the building are steel and concrete.

Peoria is the center of the country for the making of alcohol and distilling liquors, and the Corning Distilling Co. has one of the 2 largest distilleries in that city. It is at present distinguished as being the second plant of this nature to be operated by electric drive, and the only one which has been able to operate from the time of its start with the motors without any shutdown.

Outline of Process

In the Corning plant only grain is used for the production of alcohol, none of the wood or potato varieties being dealt with. The grains used in this process are corn, rye and barley, in different proportions, according to the product desired, the grain being first ground to a fine meal, keeping the entire substance, both bran and kernel together, then cooked to swell up the starch contents, then malted to convert the starch of the grain into sugar, next mixed with yeast and allowed to ferment in order to turn the sugar into alcohol, and finally distilled one or more times, as may be necessary, by a process of evaporation, to separate the alcohol from the other ingredients and to remove impurities.

The alcohol is taken to the vats for barreling, and the residue, which is technically known as "slops," but which, as a matter of fact, is a perfectly clean and wholesome mixture of grain and water, is dried out, bagged and sold to be fed to cattle. Part of it is used in a plant just across the street from the Corning plant, where 3,000 head of cattle are kept fattening all the time.

Because of the internal revenue tax on distilled liquors, the government keeps its hand firmly on all processes after the grinding of the meal up to the time the distilling has been completed and the alcohol or liquor is sold. No attention is, of course, paid to the residue, but the care that is used to avoid any unfairness is shown by the fact that every move is carefully watched by a government inspector, one being stationed in each department, and check is even kept on the amount of meal fed into the cookers. Wherever flanged joints occur in any of the piping through which alcohol is pumped, these joints are sealed with a government seal; all places where any liquor comes into sight after leaving the still are kept boxed in with glass boxes, which are locked with government locks, and all tests of the liquor must be made by means of thermometer and hydrometer inside these boxes.

For a certain amount of meal weighed into the cookers a certain number of gallons of distilled liquor must be produced for the payment of revenue. If they are not, the distiller has to pay for the liquor which

he ought to have produced anyway; so it pays to keep the plant up to a high state of efficiency.

At various points, such as the storage of the grain ready for use, the storage of the meal after grinding, the fermenting process and the aging, which is required only on whisky and takes 4 yr., according to government requirements, large storage space has to be provided. Other processes, such as the grinding, cooking and distilling, require height rather than floor area, and the machinery is packed closely together.

Handling the Grain

Figure 1 gives an idea of the layout of the entire plant. Grain comes into the elevator by dumping from the cars and is lifted by bucket elevators to the top of the building, where it is dumped into concrete bins. The elevator building is seen in the foreground of Fig. 2, the mill building being in the background, and the top of the bins in the elevator shown in Fig. 3. From the bucket conveyor the grain is distributed horizontally to the different bins by means of screw conveyors working in open troughs, and this same system is used in the basement, where the grain is taken from any one of the bins by a screw conveyor and carried to the bucket conveyor, which lifts it to the top of the building again, from which it is carried by screw conveyors and gravity to the mill building.

Before sending to the small bins from which the roller mills are fed, the grain is cleaned by machinery installed in the top of the elevator tower. From the temporary storage bins the grain flows to roller mills, which are located on the second floor of the mill building; after passing through the first break, the partly ground corn is carried by conveyors to the top of the building and dropped into meal bins, being separated into the bran and the meal proper and the fine meal separated from the coarse. The fine meal goes to the permanent storage bins for meal, while the coarse goes again to the rolls for a second break. It is afterwards taken by the elevators to the top floor and carried across to the meal building, in which are placed the large bins for the storage of meal, located directly above the cookers. From this point the meal descends through the weighing machines to the cookers by gravity, only a little of it, which goes to the yeast house, being handled by conveyors, and from the time that it leaves the cookers all handling is done by means of pumps.

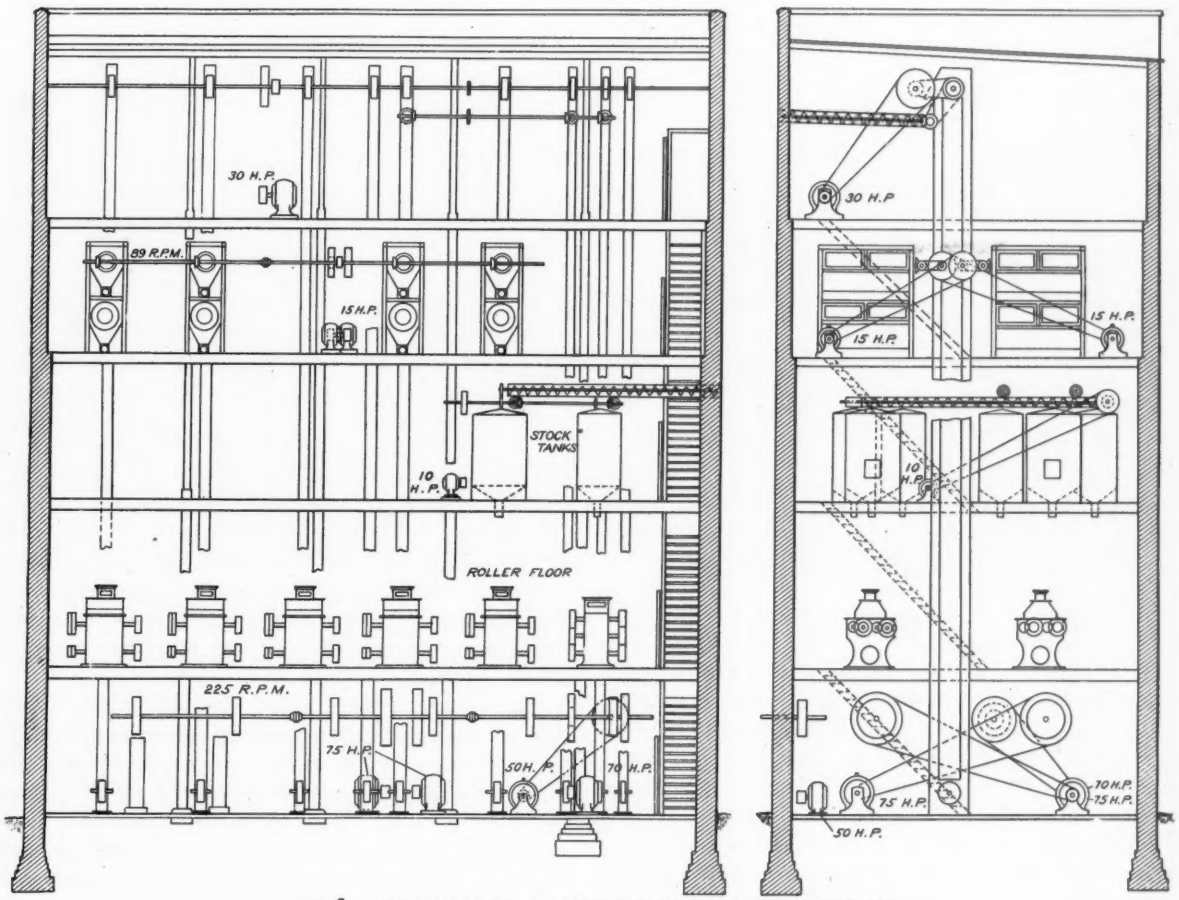


FIG. 3. ARRANGEMENT OF MOTOR DRIVES IN MILL BUILDING

Motor Equipment of Conveyors

The motor drive for the conveyors consists of a

40-hp. motor located on the top floor of the elevator tower and driving the elevator countershaft, which also runs the screw conveyors and the cleaners, the reduction being made by belting. In the basement are motors driving screw conveyors for redistributing the grain from the bins.

Elevators and conveyors in the mill building are driven from a single shaft which runs the length of the building, the motor for driving this being a 30-hp. standing on the floor. Cross conveyors, which bring the grain from the stock bins, are driven by sprocket chains from the countershaft.

Grinding the Grain

The grinding process is the same as that for a flour mill; the rollers, placed on the second floor, are 10 in number, all duplicates and placed in 2 banks, one on either side of the room, each bank arranged to be driven by a shaft beneath the floor. The motors are arranged on the first floor to belt across the room, a 75-hp. motor being used on each line.

Besides the mills used for grinding corn, which are of the Style A type, with rolls 10 by 36 in., there are 3 mills of the Style N, with rolls 9 by 30 in., one for grinding the malt, one for grinding rye and one for grinding corn for the making of bourbon whisky, which requires special treatment. The roll for malt is driven from one of the line shafts, and the roll for rye from the other, while the roll for bourbon corn, which takes an extra amount of power, is fitted with a 20-hp. motor driving onto a jack shaft pulley, and this in turn driving onto a roll pulley. The motors for driving the shafts from which these rolls are driven are all located on the first or ground floor. The 2 large motors are controlled by automatic rotary starters, and the small motor for the bourbon mill is controlled, as are all other of the smaller motors, by a square box wall starter.

In this room, besides these motors, are 3 equipments for operating stirrers in the cookers. These are 50-hp. motors, driving a shaft which extends through the wall into the cooker house. On the cooker house end of this shaft is a pinion which drives a gear on the cooker shaft.

For separating the meal from the bran and the coarse meal from the fine, 8 reels are installed on the 4th floor of the mill building, 4 reels being driven from one overhead shaft and the shaft in turn being driven from a 15-hp. motor.

After the meal has been sufficiently ground it is again mixed with the bran, as the constituents of the bran are found advantageous during the fermentation process. The ground meal, malt and yeast meal are carried to large steel tanks on the top floor of the meal building, below which are located weighing hoppers, which discharge into the cookers.

Making Malt

In explanation of the term "malt," this is produced by allowing a bed of grain, which is kept constantly stirred in a warm air, to start sprouting, the sprouts being allowed to get about 1/3 the length of the kernel, after which the mass is thoroughly dried to prevent further growth. Just exactly how this operates is a thing no one seems to know, but it produces a condition in the kernel of the grain known technically as "diastase." The meal is handled in the mill house by gravity, except that what is required for yeast is taken from the 2 tanks by screw conveyors running at 45 deg. across a bridge to the yeast house, and driven by a 10-hp. motor.

Here is where Uncle Sam takes charge. He doesn't so much care what is done in the way of grinding up meal, but when meal is weighed down into the cookers for the purpose of starting the distilling process your uncle gets interested and begins to take notice.

Cooking and Malting

The cookers are located on the first floor of the meal house, really in a part of the engine room, although in this particular case the engine equipment is considerably less than the rest of the apparatus. These cookers are steel tanks, 24 ft. long by 8 ft. in diameter, with dished heads having a dish of 15 in., the heads being of 1-in. steel and the shell of ¾ in.

A 1-in. shaft runs lengthwise through the cooker, passing out through stuffing-boxes in the heads, which act as bearings, and having also a bearing at the middle which is carried on a spider riveted to the shell. At one end this shaft carries a driving pulley and at the other a telltale wheel, so that the man operating the cookers can always tell whether or not his mixing shaft is running. At the top of the cooker is a manhole and cover, through which the meal is introduced and is bolted on after the cooker is charged. The stirrer consists of a series of arms attached to the shaft, being spaced alternately on opposite sides, so that they will sweep through the cooking mass and keep it stirred.

The cooker is filled about half full of water, and into this is stirred a charge of the meal. The manhole cover is then screwed on, live steam turned into the cooker, the temperature being carried up to 310, at which it is held for about 20 minutes, until the meal is thoroughly cooked and the starchy interior well swelled. The blowoff to atmosphere is then opened, steam having first been shut off, and cooling water turned on, and the temperature is allowed to drop to that of atmosphere, after which the vacuum pump is attached and vacuum put onto the cooker of about 28 in., giving 129 deg. temperature.

In a short time connection is opened and a certain amount of malt is drawn by the vacuum into the cooker, the proportion between malt and grain being such that there is just sufficient malt to convert the starch into sugar. The cooker is allowed to work for about 10 min., when the conversion will be found complete, and the cooked mass is allowed to drop by gravity into the mash tubs, which are covered vats located

underground just outside the mill building. In this condition the liquid portion of the mixture is sweetened water, and if boiled down becomes a kind of taffy candy.

Fermentation

The next step in the process is to pump this mash into the great vats located in the fermenting houses, the yeast being added during this process of filling, which will cause fermentation and change the sugar to alcohol. A portion of thin slop is always added to the mash as it goes to the vats, as this seems to work better than if the mash alone is used. In the smaller of the fermenting houses are 6 vats, each capable of holding 42,000 gal., and 6 smaller tanks having a capacity of 12,600 gal. each, while the larger fermenting house has twice this capacity. Seventy-two hours is required for the fermentation process, and when this is complete and the liquid is "ripe" it becomes known as "small beer," although it bears small resemblance to the commercial article of that name, and tastes very much like a badly soured batch of hen's dough.

From the fermentation vats the beer passes to storage tanks in the yard, where it is held until required in the stills. Both while in the mash tank and while in the beer tank it is kept agitated by means of stirrers, for driving which a motor is located in the basement of the elevator building. A shaft runs through the wall of this building and drives the stirrer shaft by means of sprocket chains.

Distilling

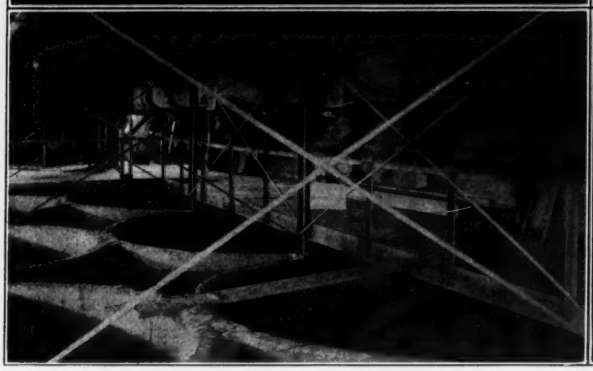
Two processes of distillation are used, one for making alcohol and one for making whisky. For cooking the malt mash a small grain cooker is installed on a platform above one end of the large cookers, and is provided with a 10-hp. motor. The mash from this small cooker goes to a mash tub located in the space between the elevator and the meal house and having a vertical shaft coming up through the bottom, on which is a stirrer. The motor for driving this stirrer is located in the lower part of the elevator building and is of 20-hp. capacity, the reduction by means of 2 countershafts with gears and pinions, being from 850 to 14 revolutions.

To produce alcohol requires a double distillation process, the first still being known as a continuous beer still, taking as its raw material the small beer from the fermenting vats and producing a 50 per cent alcohol known as "high wines," or, if below this required standard, as "low wines." The second process, known as redistillation, takes the high wines into the still and gives out alcohol or spirits.

In the continuous beer still steam is blown in at the bottom and passes upward through a series of plates in which there are ½-in. holes. These plates are put

RE-ENFORCED CONCRETE ELEVATOR AND MILL, AND BOILER HOUSE IN THE BACKGROUND

BANK OF ALLIS-CHALMERS ROLLER MILLS. 5 STYLE A AND 1 STYLE N. 600 BU. AN HOUR



TOPS OF CONCRETE ELEVATOR BINS 16 FT. DIAMETER BY 53 FT. DEEP. TOTAL CAPACITY 100,000 BU.

FERMENTING TUBS, 42,000 GAL. CAPACITY EACH, OR 1,000 BU. GRAIN

up in sections, 3 heads to a section, and the beer comes in at the top and passes downward against the current of steam. The steam as it passes upward heats the beer, and the vapor which passes off at the top will be water and alcohol with some impurities. The flow of steam is regulated so that the temperature at the bottom will be almost sufficient to vaporize the water in the small beer, at the top barely sufficient to vaporize alcohol.

Vapor passing from the top of this still goes into the shell of a device like a feed-water heater, called a beer heater, and from this shell passes off to a condenser. The small beer to be pumped into the top of the still passes up through the tubes of the beer heater, being forced by a pump which draws its supply from the beer vat.

After passing through the heater this beer is delivered upon the top plate of the continuous still and passes down through a series of openings arranged much like an open feed-water heater, against the current of up-flowing steam. Any vapor which may condense in the beer heater is taken off at the bottom by a drip and carried back into the still. At the bottom of the still is a blowoff for removing the residue or slop.

In the redistillation process the high wines, which have been stored after condensation, when coming from the continuous still, are put into a rectifier tank,

(*Continued on Page 148*)

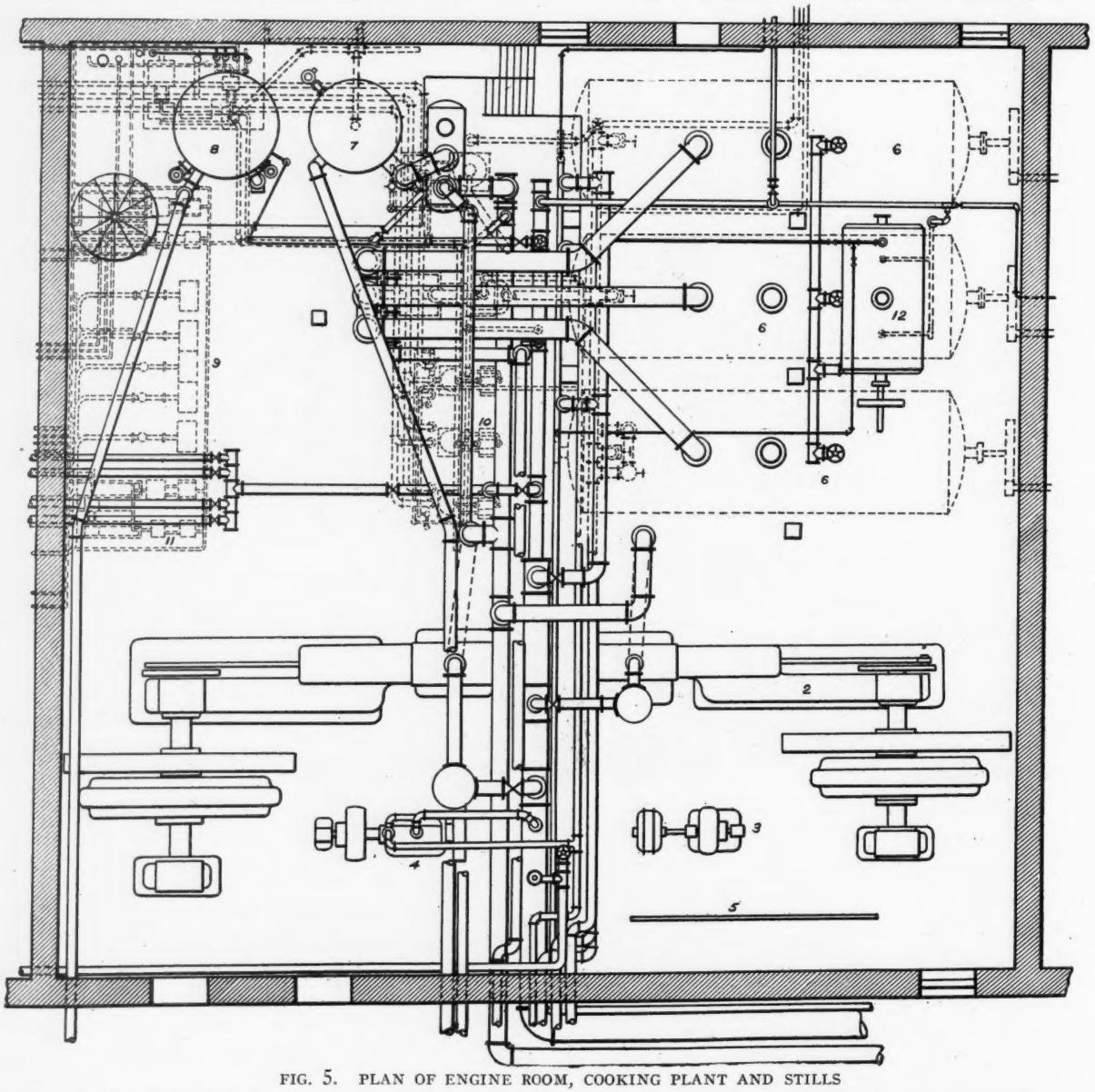


FIG. 5. PLAN OF ENGINE ROOM, COOKING PLANT AND STILLS

1. 350-KW. GENERATING UNIT. 2. 250-KW. UNIT. 3. MOTOR-DRIVEN EXCITER. 4. ENGINE-DRIVEN EXCITER. 5. SWITCHBOARD. 6. COOKERS. 7. BEER STILL. 8. WHISKY STILL. 9. TAIL BOX STAND. 10. MASH PUMPS. 11. DISTILLED LIQUOR PUMPS. 12. SMALL GRAIN COOKER.

OVERHAULING A STATIONARY ENGINE

By M. W. Campbell

IN THE work done during the past few weeks overhauling and lining up a 1250-hp. triple-expansion engine of the Dixon type, several things came up which will be of interest and help to young engineers, and very possibly to older readers of Practical Engineer.

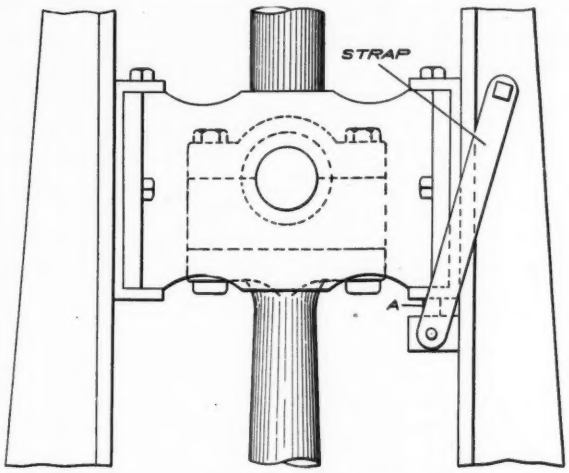


FIG. 1. CROSSHEAD HUNG UP BY STRAP

The job itself was chock full of information, so that if you want to know it is up to you to take advantage of our experience.

Tools

In the first place the tools required to do the work are expensive, yet necessary; the job could not be done without 2 1-ton triplex chain blocks and a 2-ton triplex chain block. The 1-ton blocks were used to lift the crankpin boxes, crank shaft and shaft boxes and caps out, and the 2-ton blocks to lift the cylinder head and piston. Besides these you will need 2 50-ton and 1 12-ton hydraulic jack, about 3 loads of mixed blocking 8 by 8 in. and 8 ft. long, floor blocking for raising the shaft and of course plenty of cord for lashing, from 3-in. rope down to ½-in. sash cord, as well as the regular set of steel wrenches supplied with the engine, an 8-lb. hammer and a 12-lb. sledge. In handling the shaft, 3 steel braces will be needed, 2 by 2 in. and 12 in. long, or whatever the distance is between the crank disk faces. With all these articles gotten together we are ready to proceed.

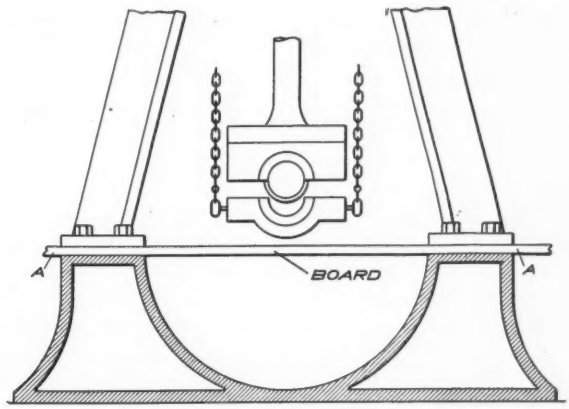


FIG. 3. LOWERING CRANKPIN BOX

FIG. 2. LOWERING BOLT OF CRANKPIN BOX

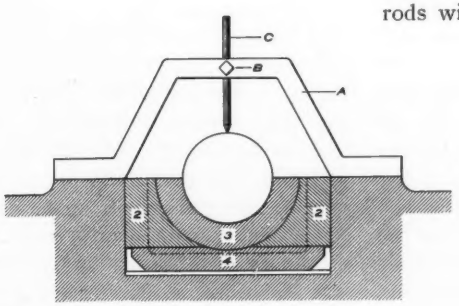


FIG. 4. TRAM AND METHOD OF MEASURING SHAFT HEIGHT

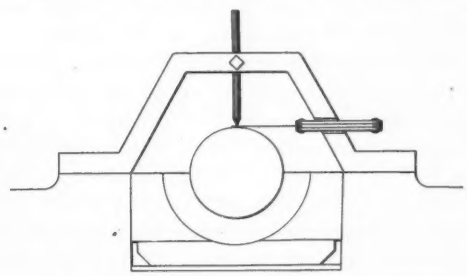


FIG. 5. USING FEELER TO DETERMINE SHAFT LEVEL

Taking Down

To start the job, all oil guards and oil pipes which may interfere with operations are to be removed; in fact, all oil pipes should be taken off and thoroughly blown out with steam; they must then be laid in a clean place until wanted. If the engine is to be put up for say a month it would be advisable also to remove the packing from the stuffing boxes and rub the rods with cylinder oil to prevent the rods from rusting. This done we jack the high-pressure engine up to the top center and procure a strap for holding the crosshead up while removing the shaft, the engine being of the vertical type. The strap for the cross-

head is put on to hold it in place with the cross bar under the slipper and two 2 by 2 by 3-in. hardwood blocks are put between the crosshead and the cross bar for the crosshead to rest on, as shown in Fig. 1 at A. The crank pin boxes are now taken off, using the 1-ton chain block and a small pair of iron blocks reeved with sash cord, the free block of the pair being small enough to pass through the nut of the pin box bolt, so that the bolts may be lowered into the crank chamber for removal, as seen in Fig. 2. Figure 3 gives us an idea

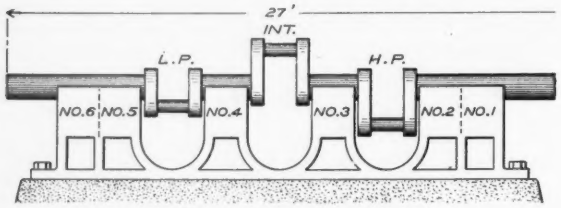


FIG. 6. SHAFT AND BEARINGS

of how to go about rigging up to take out crank pin boxes and bolts. The nuts are first loosened so that they can be turned by hand; then the eye bolts can be screwed into the bottom half of the box and the box held together tight until the small block is hooked fast to one bolt and the nut taken off so that the bolt can be lowered into the crank chamber. After this the bolt is taken out and the nut put on to protect the thread.

As these bolts are turned down to be a nice fit in the bolt holes, care should be taken not to bruise them in any way; there is no need of using a hammer, and no need to mark these parts, for you will find every part marked with a steel stamp. For instance, if you took out the front high-pressure crank end bolt, you would find it stamped H. P. 1 F., meaning high-pressure No. 1 front, and care should be taken that each bolt is put back in the proper place appointed for it. After the 2 bolts are out a 2 by 12-in. yellow pine plank is run through under the crank, resting on both sides of the bed; the bottom half of the box is then lowered on this plank by means of a block and fall, pulled out and landed on the floor as indicated in Fig. 3, where AA shows the plank in position and the bottom half of the box is shown resting on the plank.

Next comes the proposition of getting the top half of the box out; with the crosshead hung up by the strap, as already described, the engine is jacked over until the crank pin is 6 in. above the plank, then the top half of the box is rolled out onto the plank and taken out on the floor with the other half, leaving the crosshead and connecting rod hung up with the strap.

So far the work has been on the high-pressure cylinder, now the other 2 cylinders are handled in the same way, and after all crossheads have been hung up we are ready to tackle the shaft.

Leveling

For this operation a tram is used for the purpose of finding out the height of the shaft at the different bearings, as shown in Fig. 4. This is a home-made affair and does the work for which it is devised, which settles all dispute as to the correctness of its design. It is made of 1-in. square steel with a set screw, B, in the top for holding the pin, C, in place.

Having removed all the crankpin boxes, the main blocks are moved so that they will be central with the bearing caps and are hung from the frame of the engine. Beginning at the cap nearest the high-pressure cylinder, the caps of the upper half of the bearings are taken off and placed on the floor, care being taken to put them so that the inside cannot be injured. With the caps all removed the tram has the feet planed off so that it will rest even on the housings of the engine, as shown in Fig. 5, and the pin is set so that it does not touch the shaft at No. 1 bearing, and it is then held in place by the set screw. It is then

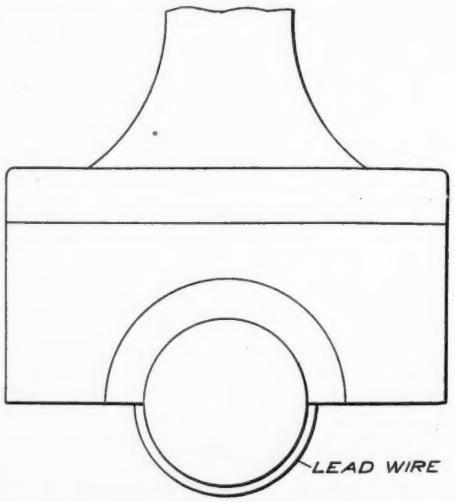


FIG. 7. MEASURING LENGTH OF LEAD WIRE

removed to the next bearing, and that is tested in the same way, so that we can tell what adjustments to make to bring the shaft to the level with the planed parts of the bed at each bearing.

We began at No. 1 bearing where there are two boxes, then tried No. 2, 3, 4, 5 and 6 and found that Nos. 3 and 4 were the highest point. We therefore set the tram at this point, and then going back to No. 1 by the thickness gage or feeler find the amount that this shaft must be raised. It was found 0.106 in. too low; at bearing No. 5 0.063 in., and at bearing No. 6 0.119 in. We then must use solid liners as far as possible to bring the shaft up to a level at each bearing. After lining up we again went over the shaft as before, measuring each bearing carefully to be certain that there was no mistake, as one bearing out of line means a lot of trouble and expense, for it means the lifting of a 12-in. crank shaft 27 ft. long in order to adjust the box.

We were very fortunate with the job, for after going over the shaft we found it trammed up true the first time, and so far so good.

Keying Up

Now came the job of keying up which most of the

boys do with a 4-lb. hammer. We do it with a 16-lb. sledge. Before starting this we want to take the leads from the engine and find out how much space there is between the crank pin and the box. This is the only way you can key up an engine and know what you are doing. I generally have 0.009 in. clearance, which I find is a good running condition with the journal boxes, and 0.007 in. clearance in the crosshead pin boxes; also 0.007 in. clearance between guide and shoe to the crosshead. This may sound like a small space, but it is not as small as you think it is. For the crank shaft I leave a 0.01 in. space, which I find carries the oil nicely, and of course gives no trouble if you don't cut the oil supply too short.

Taking Leads

To take leads means a little extra work, but it is worth while. First, the crank should be put on the top center and the bottom half of the crank box lowered so that you can put your hand between the box

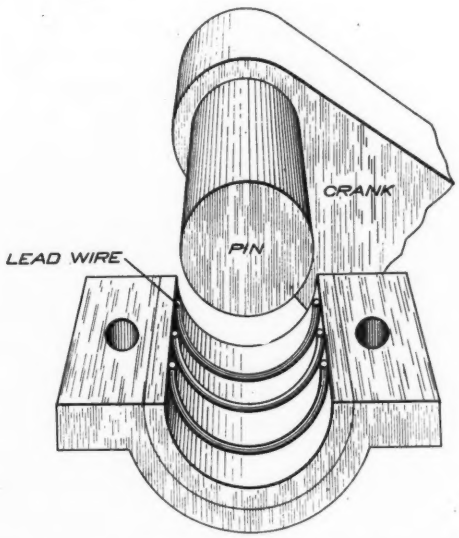


FIG. 8. TAKING LEADS FROM CRANKPIN BOX

and the pin; with a man on either side one end of the lead wire is passed under the pin to the other side and then both ends are raised together so that the ends will touch the bottom of the top box as shown by the line in Fig. 7, the wire is then cut about 0.5 in. shorter and 2 more pieces are cut the same length and laid in the bottom half of the box, 1 in the middle and 1 about 0.75 in. from each end as shown in Fig. 8. Then pull up the box and set up all the nuts as hard as you can, after which the box is let down and the leads taken off one at a time and measured with a micrometer caliper for thickness at the thinnest part. Suppose that it measures 0.015 in., this would mean too much space and would cause the engine to pound. If the following liners were placed between the boxes, say ⅛-in. brass, one 0.012, one 0.010, one 0.010 and 0.006, and if we wanted to run the pin very close we could take out an 0.007-in. liner and leave a clearance of 0.008 in. This would be rather close and it would be better to take out the 0.006-in. liner, which would leave 0.009 in. clearance. Having taken the 0.006-in. liner from either side of the box, we once more pull the box up to place and set the nuts up hard as before. We then set up the set screw on the nut and the first bearing is taken care of.

The other bearings are treated the same way except that if the crosshead has a forked connecting rod then no leads need be taken, as by running a feeler in between the top of the pin and the top box it is easy to see what to take out. The feeler in this case takes the place of the lead and for any of you who may not know what this instrument is I will say that it is known in stores as a thickness gage, and usually has 11 blades or gages in the shape of a pocket knife, each blade being numbered 2000, 3000, 4000 and so on up to 12,000 or 15,000, which means 0.012 or 0.015 in.

Having the crossheads and the crank pins all right, the next proposition is to cap the boxes. For these lead wires are laid on the top of the shaft at the middle and ends of each bearing, and with a full set of liners in each box, the cap box is put on and screwed up as far as possible. The cap is then taken off and the lead measured by the micrometer and liners taken out to give the proper space between the shaft and the top box, at either 0.009 or 0.01 in. It is well to have a mixed set of liners at each bearing, running about as follows: 0.007, 0.006, 2 tins or 0.028, 0.009, seven 0.01 and five 0.005 in. The whole amount is 0.25 or a quarter of an inch, which is expected to be allowed for the wearing until the time when it should be rebabbitted.

The time when one is puzzled is in taking the leads off a heavy engine; I remember one occasion while cleaning up our large engine we were puzzled about the leads taken from the low-pressure at the crank end, which was 16 in. diameter by 18 in. long, and 11 ft. on one side and 10 on the other. One side of the pin would measure 1/32 or 0.151, while the other side would measure 1/64 or 0.016. Well, we came to our senses after a while and straightened matters out. We just moved her back a little and got the pin central in the box, then took another lead, which came out even. It is laughable how stupid a fellow can be at times.

This engine, which is 1250 hp., is, of course, not a very small affair. It has 3 cylinders, 4 piston valves operated by the Joy valve gear, which is controlled by a hydraulic ram, this being operated by a flyball governor connected with a piston valve; the action of the governor causes the ram to rise and fall, and this is connected to a rock shaft, which in turn is connected by links and levers to the valve stem cross guide, which operates on trunnions, thus causing the stroke of the valve to be full or short down to no motion. If anyone wonders why the fourth valve is used, I will explain that the high-pressure has 1 and the intermediate 1, and the low-pressure, on account of its large size, 2 piston valves.

CROWN BARS

FORMS OF BAR AND VARIOUS METHODS OF SUPPORT

By R. T. Strohm

CYLINDRICAL and spherical surfaces subjected to internal pressure are self-supporting; that is, they do not need to be stayed in order to preserve their shapes. If subjected to external pressure, they are self-supporting to a greater or less extent, depending upon their curvature, thickness and the material of which they are made. On the other hand, flat surfaces fixed along circular or rectangular edges

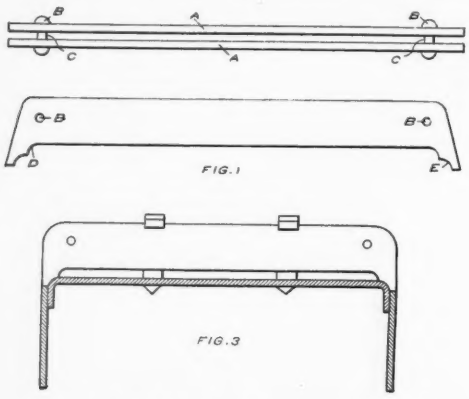


FIG. 1. ORDINARY FORM OF CROWN BAR
FIG. 3. CROWN BAR OF SHORT SPAN

are only slightly capable of supporting pressure without distortion, and therefore require staying.

In locomotive boilers and marine boilers of the fire-tube class the crown sheets and the sheets directly over the combustion chambers furnish examples of surfaces that are flat and that require staying

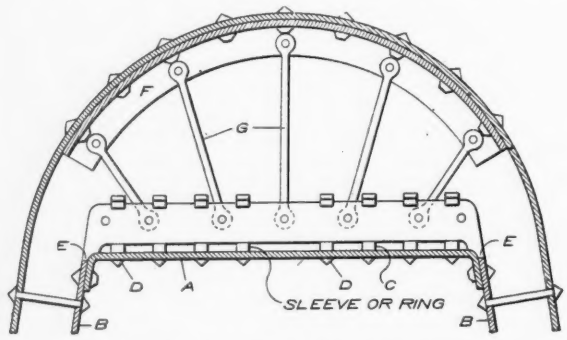


FIG. 2. CROWN BAR IN PLACE IN LOCOMOTIVE TYPE OF BOILER

or supporting in order to make them safe under the high steam pressures to which they are subjected.

Forms of Crown Bars

The method commonly employed in strengthening and supporting these surfaces is by the use of crown bars, or, as they are frequently termed, girder stays. Figure 1 shows an ordinary form of crown bar. Two flat wrought-iron bars, A, A, of considerable depth as compared with their thickness, are riveted together by rivets, B, B, but are held parallel and at the desired distance from each other by the thimbles C, C, which are merely short nipples of equal length through which the shanks of the rivets pass.

It will be observed that at D and E, the ends of the bars are cut away in a peculiar manner. The reason for this form will be apparent by reference to Fig. 2, which shows the crown bars in place over the crown sheet A of a locomotive type of boiler. The bars rest at their ends on the upper edges of the side

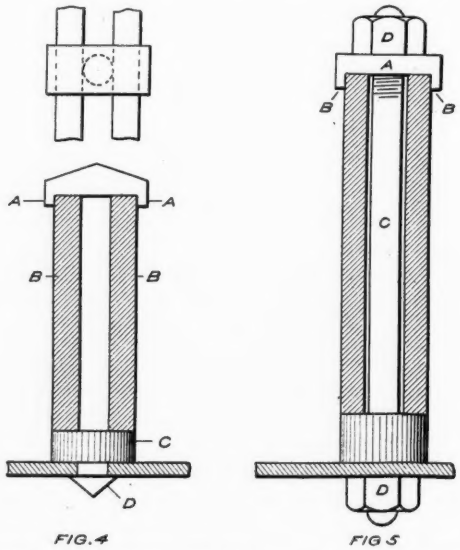


FIG. 4. METHOD OF SPACING AND RIVETING
FIG. 5. BARS BOLTED TO CROWN SHEET

sheets B, B, and the curve of the crown sheet just above the edges of the side sheets makes it necessary to cut away the crown bars so as to have them rest properly on the sheets.

Clearance from Sheet

To strengthen the flat heads of boilers it is not uncommon to rivet angle or tee irons to the inside of the heads, and it might be wondered why some such means could not be used to strengthen crown sheets, for, by Fig. 2, it will be seen that the bars do not rest upon the sheet, but that there is a space between them and the top of the sheet. The reason for this is that one side of the sheet is subjected to the radiation from the fire and the actual contact of the hot gases, and consequently it should be well protected by water on the upper side, so that the heat received may be rapidly transmitted. If angle or tee

irons were riveted flat on top of the crown sheet, or if the crown bars were so made as to lie against the sheet throughout their entire length, the transmission of heat through the double thickness of metal would be much slower, and there would be serious danger of burning the crown sheet on the firebox side.

On account of this, the lower edges of the bars are parallel to the top of the sheet, and are maintained at the desired distance from the sheet by the insertion of distance pieces or thimbles, C. They are merely metal rings of equal length through which the rivets D, D pass, and they prevent the sheet from bulging upward against the bars during the riveting process.

Tying to the Shell

Since the crown bars rest upon the side sheets at the points E, E, it is plain that the load caused by

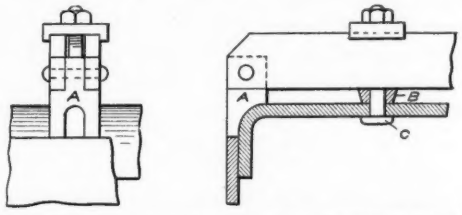


FIG. 6. SPECIAL METHOD OF SECURING BARS

the downward steam pressure on the crown sheet must be transmitted to and borne by the side sheets. This is taken into consideration in boiler design and construction, and very frequently the stress on the side sheets is relieved by tying the crown bars to the outer shell, as indicated in Fig. 2. To do this, a piece of angle or tee iron is riveted to the inside of the shell, as at F, and from it are run tie rods, G, to the crown bars. These tie rods are bolted to the bars and to the angle iron above, thus making a flexible connection.

It is not, however, absolutely necessary to connect the crown bars with the outer shell. In many cases the tie rods are left out, the whole load being carried by the side sheets on which the ends of the bars rest. If the span of the crown bars is very small, or if the steam pressure carried is low, the bars may be set as shown in Fig. 3.

Spacing of Bars

The way in which the bars are spaced and the manner of riveting are shown in Fig. 4, which is a vertical section through the crown bars and crown sheet in Fig. 2. The rivet is made with a T-shaped head that has short lugs, A, A, at its outer ends. These lugs fit down over the crown bars, B, B, and thus prevent them from spreading apart. The insertion of the nipple or distance piece to keep the bars from resting on the crown sheet is shown at C.

Fastening to Crown Sheet

Sometimes, instead of riveting the bars to the crown-sheet, bolt connections are used. Such a construction is shown in Fig. 5. A flat cap, A, with lugs, B, B, takes the place of the rivet head, and the bolt, C, with nuts, D, D, replaces the rivet. This mode of fastening is largely used in marine work.

Still another construction is shown in Fig. 6. Here the two crown bars are straight and flat and are riveted at the ends to a cast-iron block, A, that forms a foot resting on the edge of the side sheet. The square shoulder of the casting fits snugly against the bar, and thus insures firmness and prevents the block from slipping off the plate edge. The crown sheet is held to the bars by bolts having nuts at their upper ends. But instead of the cylindrical form of distance pieces, the ones here used are conical, with the small end down, as shown at B. This is so made in order to permit freer circulation of water under the crown bars, and also to reduce the amount of crown sheet surface covered by the nipple.

Suspended Crown Bars

In some boilers of the locomotive type the crown sheet and side sheets are all in one piece, or formed from a single plate. Figure 7 shows a partial half-

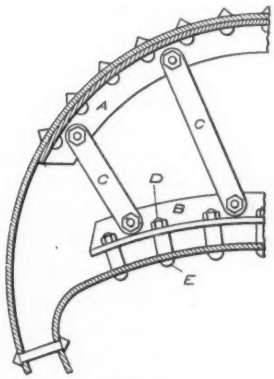


FIG. 7

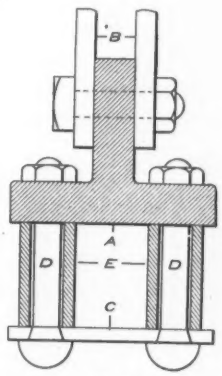


FIG. 8

FIG. 7. CONSTRUCTION EMPLOYED WHEN CROWN AND SIDE SHEETS ARE IN ONE PIECE
FIG. 8. SECTION D E FROM FIG. 7

section of a boiler constructed along these lines. It will be observed that there is no ledge for the support of a crown bar like that in Fig. 1. Consequently, a method of support similar to that in Fig. 2 is used. A tee iron, A, is riveted to the inside of the outer shell, directly over the crown bar to be supported. The crown bar itself is a piece of tee iron, B, to which the crown sheet is held by bolts. Links, C, C, are then used to hold the two tee irons together. By this construction, the entire load on each crown bar is carried by the outer shell.

The arrangement of the crown bar and supports is shown more clearly in Fig. 8, which is a section along the line, D, E, of Fig. 7. The tee iron, A, is the crown bar, to which are bolted the suspending links, B. The crown sheet is indicated at C, the bolts at D, D, and the thimbles at E. By the use of a double row of bolts, D, one on either side of the tee, and a double set of links, B, similarly located, a well-balanced construction is obtained.

GAS ENGINES AND PRODUCERS

GAS POWER IN CENTRAL STATION WORK

By A. S. Atkinson

IN HIS engineering capacity the writer has made a personal investigation of a great number of plants operated by gas power, located in the different states and including those for generating power for lighting, factory use and street railway running. With the exception of a few, the plants were in comparatively small towns and cities, those ranging in population from 50,000 down to 2,000. For the most part the electrical generators were belted and not direct-connected, but enough of the latter were used to make this form of operation of use in gathering facts and figures.

The gas engines were operated in a variety of ways, some using the illuminating gas of gas works for city lighting, and others burning their own fuel direct and a few were producer gas plants. The calorific value of the fuel gas therefore showed great variation, and this must account for many of the wide differences in results.

Fuel Consumption

The average of 20 of these plants had a capacity of 400 brake horsepower and they operated nearly every form of standard generator. From a year's operation of these plants the average gas consumption amounted to 38 cu. ft. of gas per kilowatt-hour, which, assuming an average calorific value of 625 B. t. u. per foot for coal gas, water gas or mixed gas, the heat consumption would be about 23,500 B. t. u. per kilowatt-hour, or 17,500 units per electrical horsepower or 13,500 units per brake horsepower.

Cost of Fuel

The average cost of the gas charged to the engines was 30 cents per 1,000 cu. ft. This is unusually high for the reason that many of the plants were operated upon city gas, while those which made their gas in producers economized largely in this respect. But allowing the average charge of 30 cents to stand in order to show the value of the gas plant under ordinary average conditions in a great variety of cases, we have one of the cheapest forms of electrical generation.

On the other hand, if we take the producers and the gas engines operating on cheap gas supplied at a low rate by gas companies anxious to serve power companies, we have an average cost of production as low as 20 cents per thousand. This brings the average cost of power down to 0.83 cents per kilowatt-hour of electrical generation. In such work we have an electrical generation of small units at a cost almost on a par with that of water power generation in our most favored regions.

While no attempt has been made to offer the gas engine as a competitor with Niagara and other large water power plants, it is quite evident that a large producer plant for electrical generation could acquit itself well in comparison with even such power development.

Heat Values of Fuels

In these various plants the difference in the value of the gas used is of noteworthy consideration. If reduced to heat values per foot of explosive mixture of proper constituency, it will be found that for natural gas the British thermal units per cubic foot of mixture will average 91; for coal gas, 91.7; for water gas 88; for carburetted water gas 88; for producer gas 60 to 68; for coke-oven gas 90, and for blast furnace gas 53.

To make use of these different grades of gas the size and design of the engine were important factors. This fact has been emphasized in a number of instances where attempts were made to utilize the same engine for 2 or 3 grades of fuel. For both producer gas and blast furnace gas larger sized engines were found absolutely essential to achieve economical results. If the engines were not made larger, it was found necessary to have larger cylinders which accomplished about the same purpose.

In these gases, however, the rate of combustion was much slower, and the compression could be carried much higher without fear of back firing or premature ignition. This naturally increased the efficiency of the cycle. This fact has not always been properly considered in designing engines for such work, but up-to-date practice requires it.

Water gas on the other hand produces quicker combustion and much higher flame temperatures. A saving in these plants was obtained by providing additional holders for the air or blast gas during the period when the engines are under blast. Water gas can be usel for electrical generation to good purpose under proper conditions. In fact, water gas is used today with results almost equally as good as producer gas.

Producer gas has a field almost entirely its own, and the possibilities of development in this connection with electrical generation are great. The simplicity of its installation, its high efficiency for power purposes, and its relative cheapness are all factors in its favor. Its capacity for enormous production of power and its reliability in developing a high or small load as needed gives it a great advantage over most other forms of prime mover. For electrical railway service the peak

load must always be provided for amply and the producer responds to this demand promptly. The design of the producer to utilize low grades of soft coal has greatly improved lately. In this respect the gain has approximated in economy and efficiency upward of 20 per cent.

Reliability

In electrical generation continuity of service at any cost is of the most vital importance. Any breakdown in the plant means serious trouble that cannot be permitted. Whether the plant is used for lighting purposes, electrical railway operation or small factory work, the current must be supplied uninterruptedly. The gas engine is today so thoroughly reliable that we have plenty of records of continuous operation from 1,000 to 2,000 hrs without a break or stop. At Alleghany, Pennsylvania, is an engine belted to an electrical generator that runs regularly the whole week and is shut down on Sundays only for cleaning and inspection. This weekly shutdown is not necesary, but is taken as a wise precaution. In another electrical central station at Newburgh, New York, is a battery of 5 engines driving electrical generators for a large manufacturing shop. The engines are run continuously every day in the week, and inspected Saturday afternoons by an expert. In the year that they have been in operation there has been no other shutdown, and they could run Sundays too if needed. The source of the power is thus certain, and is considered as reliable as any method yet devised for driving the plant.

Simplicity

Next to continuity of service in electrical work is the need of simplicity of operation so that the paid attendance can be reduced to a minimum. This means economy of operation. Probably less skill is required to run a gas plant than any other. This should not, however, be taken as an indication that an unskilled worker can attend to the gas engine. To make such a claim is to invite disaster. The operator should be just as skilled in knowing and understanding his gas engine as the steam engineer. Steam engineers as a rule make excellent attendants for gas plants.

First Cost

In the matter of cost of equipment the gas engine is easily comparable with that of a steam plant. Ordinarily the gas engine itself costs more than the same size steam engine on account of the greater amount of metal it requires, but this is true only when we consider the steam engine without the condensing machinery. Where natural or illuminating gas is used the equipment should cost a good deal less than the steam plant thoroughly equipped with condensers, pumps and heaters. For each 1,000 horsepower developed the producer gas plant is about on equality with the steam plant in the initial cost of installation. But the saving in cost of operation is largely in favor of the gas plant.

This has been figured out on the following basis from data collected from a great number of plants. At full load a gas engine will deliver easily a full British horsepower upon considerably less than 10 ft. of gas, allowing 900 to 1,000 B. t. u. to each cubic foot, which is equivalent to 10,000 thermal units per horsepower. To evaporate 10 pounds of water from each pound of good coal is a performance that requires care and an efficient boiler, and for each horsepower thus developed the gas engine has an advantage in cost ranging from 10 to 40 per cent.

Gas Engine Advantages

In central station electrical work the gas engine of any type has certain advantages that have been demonstrated in a large number of cases. There is first the minimum heat and fuel consumption, an advantage which is most important for the reason that our cost of fuel is tending steadily upward and the quality obtainable is degenerating.

The second great advantage is that the gas engine has a high light load efficiency which in an electrical plant means an enormous saving; for the light load period is often extended over half the day and night.

Low cost of maintenance and operation of a gas plant is a factor that with scarcely an exception holds in nearly every kind of plant. The gas engine may not be fool proof, but it will stand more careless attendance than most machinery.

Simplification of equipment is an important advantage for the reason that there are fewer parts to get out of order and fewer accidents and mishaps likely to occur. In connection with this advantage there should be considered the small number of auxiliaries required for a gas plant.

Quick starting is a factor of far-reaching effect in an electric generating station. In a battery of gas engines any single unit can be started cold in an emergency without trouble, and the avoidance of a temporary shutdown is thus assured. How much this means in central station work can best be appreciated by engineers in charge of such plants.

Another advantage closely associated with this is the case of extending the equipment. A new battery can be installed without trouble or without affecting those already in operation. A plant that is growing thus increases its output with the increase in the business. In gas producers for central station work there is a great economy obtained through the storage of power during light loads in the form of gas in the holder. This makes it possible to supply the peak or heavy load with all the power that is needed at small cost. The subdivision of units is obtained without trouble or cost so that at any hour of the day the power can be proportioned to the needs of the plant.

Finally, there is the utilizing of the waste heat in the water from the jacket for heating buildings and for drying and bleaching purposes. This latter gain has recently become an important advantage, and some factories and central stations have achieved an important economy through it.—Gas Review.

SUCTION GAS PRODUCER POWER

FUELS—THEIR COST AND HEAT VALUE

By L. P. Tolman

Anthracite in buckwheat or pea sizes, lignite, coke, and charcoal are the fuels commonly used. In many sections these small sizes of anthracite can be bought cheaply in car lots. For example, in Chicago the carload price of buckwheat anthracite is usually about $3.75 a ton. In some of the states west of Chicago the price varies from $5 to $7 a ton. At some points in southern Canada these small sizes of Pennsylvania anthracite can be bought for from $3 to $4 a ton. In some of the eastern states, which are nearer the source of supply, the prices are even less.

The lignite producer offers a wonderfully cheap and reliable power in sections where this fuel is available. There are enormous deposits of lignite in Texas,

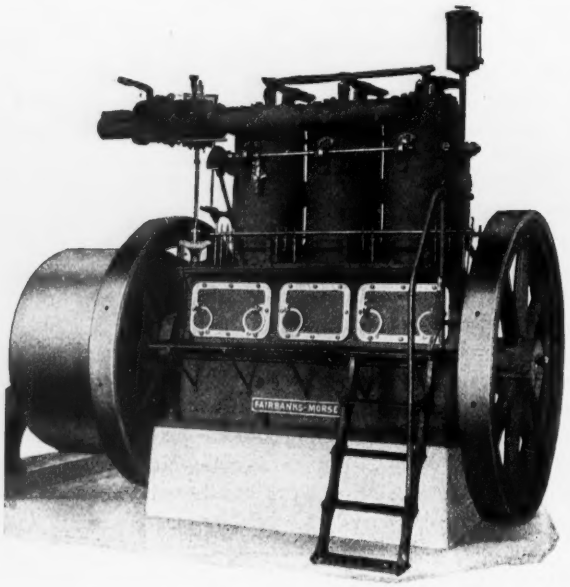


FIG. 4. 3-CYLINDER VERTICAL GAS ENGINE

Arkansas, Louisiana, North Dakota, Montana, Wyoming, Colorado, and other western states. This can usually be had at a price of from $1 to $3 a ton. At Smithville, Tex. where a 150-horsepower lignite producer plant is installed, the cost is $1.70 per ton. Lignite is of little value for steaming purposes, mostly due to the large amount of moisture, but it makes a most excellent fuel for the producer and in some respects is easier to handle than anthracite.

Coke and charcoal are economical fuels in some sections and can be used separately or mixed with anthracite.

In order to give some idea of the relative value of different producer fuels, the results of tests on a number of samples are given. These samples were received from various parts of the United States, as well as from foreign countries. For example, in Table I, giving the analysis of different anthracites, sample 65 is from Europe, 101 and 76 from Pennsylvania, 71 from Elk Mountain, Col., and 89 from Banff, B. C., Canada. The following tests were made by the experimental department at the works of Fairbanks, Morse & Co., Beloit, Wisconsin.

With the best coal there is little formation of clinker that will not work down to the grate without poking from the top, and many European producers have no top poke holes. These are not successful on American coals, for while it is always desirable to get the best of coal, it is practical to operate continuously on an average, or even a poor coal, by working the clinkers down through top poke holes. It is an advantage in using poor anthracite to have large producers.

TABLE I. COMPOSITION AND FUEL VALUES OF ANTHRACITE COALS

SAMPLE NO.	B.T.U., PER LB.	FIXED CARBON	VOLATILE	ASH	MOISTURE	SULPHUR	QUALITY
65	13,434	88.8	7.4	2.9	.9	.99	VERY GOOD
101	13,952	83.5	5.5	8.2	2.8	.82	GOOD
76	12,058	73.9	5.7	18.9	1.5	.86	POOR
71	13,332	77.2	9.3	13.4	.1	.73	FAIR
89	14,746	79.3	8.1	10.5	2.1	.59	GOOD

TABLE II. COMPOSITION AND HEAT VALUE OF COKE

SAMPLE NO.	B.T.U. PER LB.	FIXED CARBON	VOLATILE	ASH	MOISTURE	SULPHUR	QUALITY
73	12,787	86.7	2.4	8.4	2.5	0.93	GOOD
77	14,213	92.3	1.7	5.8	0.2	0.6	VERY GOOD
94	9,528	79.4	3.7	14.3	2.6	0.59	RATHER POOR
97	13,811	90.4	1.7	6.1	1.8	0.55	VERY GOOD

TABLE III. COMPOSITION AND HEAT VALUE OF LIGNITE

SAMPLE NO.	B.T.U. PER LB.	FIXED CARBON	VOLATILE	ASH	MOISTURE	SULPHUR
51	11,634	20.3	46.1	6.3	27.3	1.01
57	8,753	29.4	35.7	7.1	27.8	0.63
95	11,568	41.8	36.7	3.7	17.8	0.41
103	9,765	36.8	35.8	10.7	17.2	4.09

Coke

This fuel varies in quality according to the soft coal used in its manufacture and the method of treatment. All coke must be crushed to pass a screen of 1-inch or 1.25-inch mesh, and must be freed from dust with a fine screen. It is usually advisable, where coke is used, to install one size larger producer than standard. A sawdust purifier is also desirable to remove dust, which is more abundant than with anthracite.

Gas from coke averages about 115 B. t. u. per cubic foot, while from anthracite it averages 125 or more. For this reason the power capacity of the en-

gine will be a little less on coke gas, but not as much less in proportion as the heating value. Some coke will not maintain the fire hot enough. Mixing 1 part anthracite with 2 of coke usually corrects this.

Charcoal

This contains B. t. u., per pound, 14,438; fixed carbon, 81.3 per cent; volatile, 12.9; ash, 1.1.

The use of this fuel becomes practical by the addition of a centrifugal tar extractor located between the scrubber and a sawdust purifier. With this fuel, also, it is advisable to install one size larger producer than with anthracite.

Charcoal gas has a heating value averaging 130 B. t. u. or more, and because of this gives somewhat more power at the engine. It can be used in as large pieces as will readily go through the producer charging hopper. Less tar results from charcoal that is perfectly charred, but more or less material not perfectly charred is likely to be found. No clinkers are formed with this fuel.

Lignite

Lignite cannot be used in standard anthracite producers, but the Fairbanks-Morse lignite producer operates successfully with this fuel. Gas from lignite averages 130 B. t. u. per cubic foot. This fuel can be fed to the producer in any size that will go through the charging hopper and it causes no serious trouble from clinkers.

Producer Gas Engines, Vertical Type

These engines are made in sizes of 200 horsepower and smaller. By combining several units, plants of 800 to 1000 horsepower or larger have been installed. Figure 4 illustrates a thoroughly modern engine of this type. Sectional view is shown in Fig. 5. It may be of interest to engineers to note briefly a few of the carefully developed features in the design of these engines.

The present system of ignition is a great improvement over the methods formerly used. The make and break igniter is so constructed that it can be adjusted to spark as early or as late as desired, when the engine is running or at rest, by means of a convenient hand lever. A single lever controls the time of ignition for all cylinders. This is a feature of much importance, especially with producer gas, as it permits timing the ignition to give the greatest possible power and economy with any particular grade of gas, and when the engine is running. In addition, there is an independent adjustment for each igniter, which is operated by drop cam.

Igniters can be removed, inspected, and cleaned, without interfering with other working parts, and they are located most conveniently. As the successful operation of a gas engine depends largely upon the igniter, the value of these features cannot be emphasized too strongly.

Both valves are mechanically operated from a single cam shaft, which is located inside the crank case, which minimizes the amount of noise; furthermore the 2 to 1 reduction of gearing includes a pinion which is made of alternate layers of steel and red fibre. These features insure a quiet running engine.

The simple flyball governor is most carefully designed, and operates a balanced disk valve which is so constructed that there is no frictional contact or surface to become fouled by any impurities in the gas. The governor insures very close regulation, adapting the engine for electric lighting and other service requiring uniform movement.

Lubrication is effected by means of a single elevated oil reservoir, which is provided with separate brass pipe with individual sight feed for each bearing, a most effective system of engine lubrication which has been adopted as the best to be had. The drip from the different bearings collects in the base of the engine, which is drained by means of a small pump. The oil is run through a filter and is then used over again.

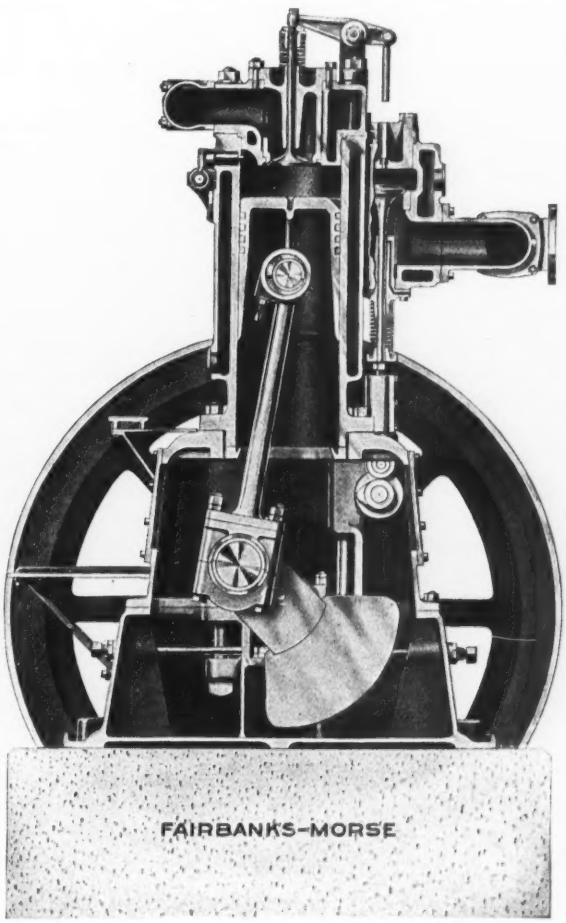


FIG. 5. SECTION OF VERTICAL GAS ENGINE

Each engine is fitted with a hand-operated speed regulator, by means of which speed can be reduced when engine is running.

One cylinder of each engine is fitted with automatic compressed air, starting gear, which can be thrown

into or out of action by the movement of a single lever, and the engine is started automatically on compressed air.

The fuel consumption with producer plants depends upon a number of conditions, such as the quality and heat value of the coal used, the freedom from clinkers and excessive amount of ash, whether the engine is operating under nearly full load or under very light loads, and also whether the load is constant or rapidly fluctuating. Much also depends on the operator in charge of the plant. A careful and intelligent engineer will secure economical and reliable service. With a steam plant it is usually necessary to employ a licensed engineer, which has been found necessary owing to the danger involved in the careless handling of steam boilers. With the producer this danger is avoided and it is not necessary to employ a licensed engineer, although the best results can always be secured by employing an intelligent operator and one who will take a personal interest in the plant under his charge.

The fuel consumption usually varies from a pound to 1.25 lb. per brake horsepower per hour at about full load, according to conditions and the quality of coal used. While economy tests with high grade fuels, and also short run tests, often show a lower consumption than stated, yet the figures submitted are conservative and give a fair idea of what may be expected.

A series of tests were recently made on a 150-hp. Fairbanks-Morse engine and anthracite producer for continuous runs of 24 hr., the object being to determine the comparative economy at different loads. The coal used was an ordinary grade of buckwheat Pennsylvania anthracite. The fuel consumption per brake horsepower-hour at less than full load was found to increase per unit of power developed as follows:

Three-fourths load—consumption 5.6 per cent more per horsepower-hour than at full load.

One-half load—consumption 21.5 per cent more per horsepower-hour than at full load.

As the ordinary engine in use has a load factor of from 50 to 75 per cent, the above figures indicate that the producer gas engine is economical, even under light loads.

GASIFICATION OF LOW GRADE FUELS*

By L. G. Findlay

PROBABLY the ideal method of treating hydrocarbons is to convert them into fixed gases by passing them through an incandescent bed of fuel, but in actual practice this method, which is called the re-entrant principle, shows no greater efficiency than the ordinary pressure producer in which tar is extracted by centrifugal washers. In using this method some producers are built with 2 incandescent zones and 1 producer shell, one having the down draft principle and the other the up draft. This design has usually proved too delicate for the ordinary attendant to handle.

Another design has 2 shells, all the hydrocarbons being made in the first and passed into the second. This is not so delicate as the first method but more costly. In nearly all producers of this type the hydrocarbons from the first zone are drawn out by induction blowers, which carry them to the entrance into the second zone, where they meet a fresh supply of air and are burned.

Almost all the large installations for low-grade fuels are of the pressure type with centrifugal tar extractors and a number of those first built on the re-entrant principle are now having the centrifugal washers attached because the re-entrant method does not give an absolutely clean gas for engines under varying load.

Probably the only producer of this type which has met with complete success is that designed by Jahns, a German engineer. This consists of a combination of 4 furnaces in 1 unit, several units forming the plant. The single furnaces are charged and burned without replenishment of fuel, cleaned and then recharged again, thus forming a cycle. The various single furnaces are operated in rotation and in such a manner that the volatile gases are drawn from 1 and passed through the incandescent zones of another furnace. After a furnace is exhausted, it is shut down, cleaned, recharged and started up again. A plant of this type has been operating for 6 yr. at a German mine using mine refuse which contains only 20 per cent of coal. It will gasify the various culm piles around our mines without difficulty and should be considered in connection with the many plans on foot to establish large central gas power plants in the coal regions for supplying light and power within a radius of 150 to 200 miles.

In Staffordshire, England, a company is supplying Mond gas to a number of towns over an area which will ultimately comprise 123 sq. mi. This gas is being used by the iron, steel, glass, firebrick and other industries. Such plants indicate the future progress of the gas producer industry in this country, as besides obtaining a supply of cheap gas for both industrial and power purposes, a number of other advantages are secured, such as the elimination of the smoke nuisance, which is more to be desired than its abatement, and the dirt and cost of supplying coal and removing ashes from a number of independent steam plants as is the case today. In fact, I believe the time is not far distant and will probably be coincident with the failure of natural gas, when producer gas will be supplied through mains to an even greater area than is now supplied by natural gas.

Besides the anthracite coals of pea and No. 1 buckwheat sizes, which nearly everyone knows are gasified, all of the cheaper grades, such as No. 3 buckwheat, bituminous, slack, coke breeze, lignite, peat and hard woods can be gasified by some type of producer.

*Abstract of a paper before the Ohio Society of M. E. and S. E.

Probably the greatest agent for the gasification of lignite, peat, mine culm and bituminous is the byproduct ovens from which the byproducts such as sulphate of ammonia, etc., are simultaneously recovered.

The oldest of these was designed by Dr. Mond and built in Norwich, England. The following statements are given out by the Mond people, showing the net cost of power, first when recovering ammonia, and the second without such recovery.

No. I.

Annual Working Cost of a 20,000 i. hp. Plant Working Continuously, but Under a Variable Load, Which is Equal to Half Load Throughout

Total Fuel (46,125 tons),* including that required to raise all necessary steam, and also stand by losses of half plant when standing for 12 hours every day at $1.45 per ton	$ 67,112.87
Wages at producers, boilers, sulphate recovery and evaporation plant, including handling of coal and ashes, also shipping of sulphate	19,948.68
*Note.—1 ton = 2,240 lb.	
Sulphuric acid at $7.27½ per ton, also lubricants, lighting stores, repairs (including wages and materials for same)	19,450.92
	$106,611.47
Less 1,460 tons sulphate at $48.50 per ton	70,810.00
Net cost per annum	$ 35,801.47
Cost of available gas per 1,000 cu. ft	$ 0.006934
Cost of 1 indicated hp. per hour	.000416
Cost of 1 indicated hp. for 1 year of 365 days of 24 hr	3.68
If coal be taken at $1.94 per ton—	
Cost of available gas per 1,000 cu. ft	$ 0.011266
Cost of 1 indicated hp. per hr	.000676
Cost of 1 indicated hp. for 1 year of 365 days of 24 hr	5.98

No. II.

Annual Working Cost of a 1,000-hp. Plant Working Intermittently, Say 300 Days per Annum for 12 Hours Per Day, at an Average of Two-thirds of the Full Load

Total Fuel (1,200 tons), including that required to raise steam for the machinery and producer (evaporation 6½ lb. per pound of fuel), also for stand-by losses for 65 days of 24 hr. and 300 nights of 12 hr. at $1.45 per ton	$ 1,746.00
Labor—1 man at $1.21 per day for 300 days	363.75
Other expenses, including maintenance, repairs, cost of oil, waste, stores and sundries	575.93
Total working cost per annum	$ 2,685.68
Cost of available gas per 1,000 cu. ft	$ 0.01916
Cost of 1 indicated hp. per hour	.00114
Cost of 1 indicated hp. for 1 year of 365 days of 24 hr	10.075
If coal be taken at $1.94 per ton—	
Cost of available gas per 1,000 cu. ft	$ 0.022624
Cost of 1 indicated hp. per hour	.001357
Cost of 1 indicated hp. for 1 year of 365 days of 24 hr	11.8960

REORGANIZING AN OLD WATER POWER.

THERE are doubtless many plants deriving considerable water power from old developments in which both volume and efficiency could be materially increased by a complete reorganization in accordance with the most recent practice. And not only may the power end be benefited thereby, but the good results there possible of attainment may be considered in conjunction with relocation or reconstruction of the manufacturing building or buildings, so as to secure the maximum of convenience and efficiency. A typical case of this nature is presented by a reorganization conducted under the supervision of Chas. T. Main, mill engineer and architect of Boston, which successfully embraced both of these advantages, as is evident from the following brief description:

The complete plant of the mill in question formerly consisted of 3 separate installations, each with its own individual dam, water wheels and buildings, all situated within a distance of about 1,200 ft. The head of water at each dam varied from 10 to 18 feet.

The improvements started with the elimination of the 2 down stream dams and the selection of the remaining up stream dam for service in the new development. By this combination a total head of 40 ft. was obtained. From the up stream location the water was carried through a steel penstock to a modern and comparatively small water wheel somewhat below the farthest down stream dam. At this point a new manufacturing plant was erected to take the place of the scattered buildings. In this were incorporated many improvements in the way of manufacturing equipment.

The advantages of the reorganization were evidenced in 2 ways; by the concentration and utilization of a better conserved water supply under a greater total head, on the one hand, and by the grouping of the manufacturing buildings on a single building site upon the other.

The expense of upkeep of the 3 original dams was reduced and limited to that upon 1, while the loss of head between them, inevitable under the old conditions, was eliminated. By selecting the up stream site for the single dam and carrying the water by penstock to the new site at a considerable distance down stream, the maximum head was utilized. It is evident that had the down stream location been selected and the same head provided at the wheels a new dam would have been required.

The combined power at the best was relatively small, but when divided into 3 units, as in the original installation, the friction losses were excessive. By the adoption of the new plan, it became necessary to keep only 1 dam tight in order to conserve the water, the excessive leakage through the other 2 was eliminated, as was also the amount passing by the water wheels during the night. In every way the new plant was more efficient and more easily operated. The power available at the new mill is now sufficient to run the entire plant several months of the year.

ELECTRICAL MACHINERY AND APPARATUS

THE INDUCTION MOTOR

By Edson R. Wolcott

The induction motor differs from all other types of electric motors in that no current is conducted into the rotating part. The simplicity of this form of motor is clearly shown in Fig. 1, which illustrates the various parts of a three-phase motor before the armature shaft is mounted in the bearing housings.

The framework, with its attached windings, is called the primary or stator. There are three electrically distinct windings arranged as in a three-phase alternator. The cylinder, which is the rotating part, is called the armature, secondary or rotor. As seen in the illustration, there are no collecting rings or terminals of any kind connected to the rotor. The only electrical connections are those shown at the left of the stator. They are connected to the mains of a three-phase alternating current circuit through a starting device which will be described later.

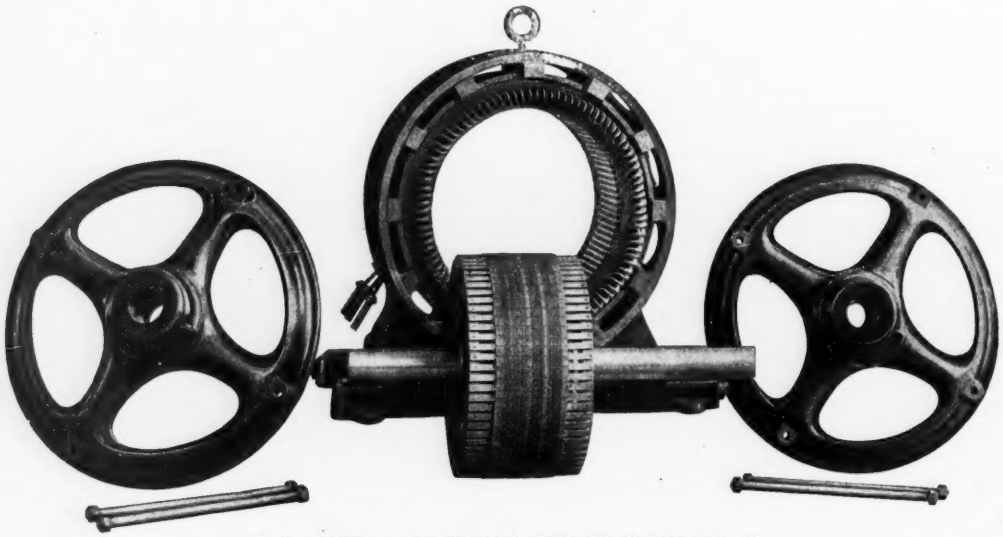


FIG. 1. PARTS OF ALLIS-CHALMERS INDUCTION MOTOR

Rotor Current

Although no current is conducted into the rotor, an induced current is generated therein just as soon as the windings of the stator are connected to an alternating current circuit. It is well known to all students of electricity that whenever an electrical conductor moves in a magnetic field, or whenever a magnetic field fluctuates in the vicinity of a conductor, an electric current is generated in the latter. This is the fundamental principle upon which all dynamos are constructed, as well as the main principle underlying the operation of transformers. An alternating current flows through the primary coil of a transformer and generates a fluctuating magnetic field in the path of which lies the secondary coil. A current is induced in the latter coil corresponding in its variations to that flowing in the primary.

The induction motor is, in reality, a transformer, the secondary of which is mounted so as to rotate. It is for this reason that the stator and rotor are sometimes called, respectively, the primary and secondary. The passage of an alternating current through the windings of the stator induces currents of electricity in the heavy copper bars of the rotor, which lie partly imbedded in iron, as shown in Fig. 1. Their projecting ends are all connected to two circular copper bars, being thus short circuited. The electromotive force generated in the rotor is not large and the conductors are therefore of low resistance in order to permit the passage of currents of amperage sufficient to generate the required horsepower.

Starting

Although an ordinary single-phase alternating current, when passed through any one of the stator windings, will induce currents in the rotor and keep the latter revolving and doing work if once started, yet, the motor cannot be started by a single-phase current.

If, however, the windings of the stator are arranged in a manner similar to those of a two-phase alternator and are connected to such a generator, the motor is then self-starting. The same thing holds true for a

three-phase system, and, in fact, for any polyphase system.

3-Phase Action

A two-phase alternator has an armature wound for two separate circuits; an alternating current is generated in each one, but they do not fluctuate in unison with each other. One of them reaches a maximum when the other has a zero value. Likewise, the currents in each of the three circuits of a three-phase system are out of step with each other. This can be more clearly understood by reference to Fig. 2, which represents a three-cylinder engine, the pistons of which operate on the same crank to rotate the shaft in the direction indicated by the arrow. The pistons are each out of step with the other two, one is near the bottom of the cylinder when another is near the center, and the third is near the top of their respective cylinders. This arrangement is in many ways analogous to a three-phase induction motor. The three phases combine to produce a rotating magnetic field within the stator.

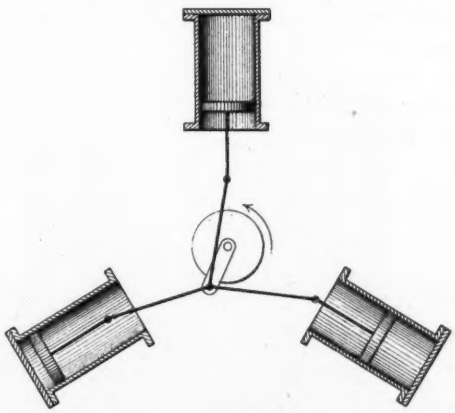


FIG. 2. THE 3 PISTONS WHICH ACT LIKE 3-PHASE CURRENTS

just as the three piston rods combine to produce a rotation of the shaft. When two of the piston rods are disconnected the shaft will still rotate under the action of one cylinder. Likewise, when one of the three terminals of the motor illustrated in Fig. 1 is disconnected, two of the three phases are cut out and the rotor revolves as a single-phase induction motor. Assume that the engine operating on a single cylinder always stops at dead center, then the engine would not be self-starting and its action would be analogous to that of the induction motor operating on one phase.

To recapitulate: the inductor motor is operated by an electric current which is induced in and not conducted into the armature. It cannot operate at all when the stator windings are connected to a direct current circuit, for under such circumstances the magnetic field is steady and a current is not then induced in the armature. It will operate when connected to a single-phase alternating current circuit, but it is not self-starting. When a polyphase current flows through the stator windings a revolving magnetic field is generated which not only makes the motor self-starting, but makes the motor more efficient in several ways.

The exact manner of the production of a revolving magnetic field, as well as the advantages to be derived therefrom, will be described in a future issue.

OIL-COOLED AND OIL-INSULATED TRANSFORMERS *

By John Pearson

OF THE 2 types of transformers, the air-cooled and the oil-cooled, the oil-cooled is the stronger and will stand greater strain. In case of lightning, if the working current does not follow the discharge, the oil will close in and insulate the coils; but, in the air-cooled transformer, even if the static discharge is through a hole the size of a needle, the working current will instantly follow and start burning the insulation.

In the case of high-tension transformers, there is difference of opinion as to the best way to connect. One engineer prefers delta connections and another star connections. With delta connections, if one transformer becomes disabled, a large portion of the load can be taken care of by the remaining 2 transformers, which cannot be done while one side is connected up in star. The writer prefers the star connection on the high-tension side of transformers with the neutral or center of the star grounded. A static bypass can then be put across each coil to take the lightning discharges.

In 2 years' experience with air-cooled transformers in the St. Croix Power Co.'s station, it was not unusual to see 1 or 2 transformers burn out during a lightning storm. With the static bypasses put on and the neutral grounded, transformers have worked for 2 years without a single burnout.

Oil Insulation

Speaking before the same society, F. R. Cutcheon said that current from the St. Croix Power Co.'s plant is carried underground at 25,000 volts into the heart of the business district and there stepped down in the St. Paul Gas Light Co.'s Cedar Street station for use at 2,200 volts and in 6-phase rotary converters. The transformers for the converters are 6 in number of 300-kw. capacity designed for 22,500 volts on the high-tension side and 78 volts delivery. Also there are 4 200-kw. transformers having the secondaries brought out in 25 taps at 1 terminal with 20 volts between taps, thus giving a range from 2,100 to 2,600 volts. These are connected to change from 3 to 2-phase with an extra primary tap to give the right ratio. All transformers are oil-insulated and self-cooling.

Starting Up

When the plant was started, it was found that the synchronous converters did not deliver a sufficiently high voltage with the transformers connected

* Read before the Minnesota Branch of the A. I. E. E.

in delta. In order to get the necessary increase, connections of the primary coil were changed from series to multiple and the bank connected in star instead of delta on the primary side. This gave an increase of 15 per cent in the secondary votlage.

Regulation

On account of the 2 systems of transmission, difficulty was found in regulating the station. On the 2,100 volt line the requirements were a variation of only from 2,080 up to 2,160 volts, a range of less than 5 per cent. On the direct-current busbars the current varied over 20 per cent so that to regulate the e. m. f. on the direct-current system the voltage on the high-tension line had to be changed from 20,000 volts at light load to 25,000 during the peak. With this latter voltage, the alternating-current distribution voltage, could not be less than 2,300 volts which will necessitate the use of automatic feeder regulators to absorb the excess voltage.

Heating

Originally, it was intended to put the transformers in the main dynamo room with good ventilation but later developments made this impossible and they were placed in a small closed basement. They could not be kept cool there except by blowing large quantities of air through the basement and, even with a 10-hp. blower, the temperature rose as high as 180 or 190 deg F., under which conditions the makers were not willing to guarantee the transformers.

They settled the matter by putting in water cooling coils, sinking a 250-ft. well from which water comes usually at 40 to 50 deg. F. and using about 50 gal. a minute to cool a total capacity of 2,700 kw. in transformers and induction regulators.

This introduced new troubles, as the atmospheric condensation on the pipes ran into the oil sometimes carrying a gallon of water in 1 week into 1 transformer. To remedy this, the pipes that were exposed to air were covered with magnesia pipe covering.

The amount of water used in the transformer was regulated by reading a thermometer placed in the oil and regularly read during overload periods. When a transformer begins to heat, it seems to exert a back pressure on the water supply and stop its flow in that coil so that it is necessary to shut off the other coils and force water through the hot coil until the transformer is cooled down.

Leakage

Trouble was found with the leakage of oil, at first from cracks in the transformer which apparently could not be stopped by caulking or varnishing, and later by soaking up between the strands of the 2,200-volt leads and forming a siphon which, when well started, would remove several gallons of oil a day. To remedy this, the insulation was stripped in the highest point of the leads and the spans soldered together.

When first installed, the transformers for the synchronous converters were connected up with single-conductor, lead-covered cable, but the induced current in the lead was so strong as greatly to increase the heating of the cable, and, where cables came in contact, short circuits occurred. Finally, a large part of the lead was stripped off and the remainder insulated with wooden clamps.

Having recently installed a 1500-kw. steam turbine generator at the steam plant, an endeavor was made to use four 200-kw. transformers to step up so as to operate the synchronous converters from steam power. It has been found that the ratio of the transformers when so used is even worse than when used as step-down transformers, as the voltage necessary to supply the internal drop from the low-voltage end is greater than that needed when such loss is supplied from the high-voltage end.

CURRENT CONSUMPTION OF LAMPS

By M. C. Saeger

THE accompanying data have been arranged for the benefit of current consumers with an eye to economy. The lamps have been tested with Weston standard instruments.

The Tungsten lamps listed here are the products of 3 different manufacturers. It must be borne in mind that all Tungsten lamps burn at a higher efficiency at 3 or 5 volts lower than rated on the lamp, while 3 or 5 volts makes very little difference in the candle-power. These lamps are more expensive than the ordinary carbon filament type, therefore the best practice of economy would be to consider the cost before the attainment of an extra candlepower or 2. Tungsten lamps on a general average have a life of 500 to 700 hr. and will in time more than pay for themselves. The results given have been taken from the average of 6 new lamps for each test.

POWER CONSUMED BY LAMPS

CARBON FILAMENT LAMPS					
RATING ON LAMPS			TEST		
C.P.	VOLTS	WATTS	AMP.	WATTS	VOLTS
4	115	—	0.16	18.08	113
8	115	—	0.27	30.51	113
6	115	—	0.23	25.99	113
10	52	—	0.75	39.00	52
20	118	50	0.39	44.07	113
75	118	187	1.48	165.76	112.
40	118	100	0.84	94.92	113
TANTALUM LAMPS					
RATING ON LAMPS			TEST		
	VOLTS	WATTS	AMP.	WATTS	VOLTS
—	120	25	0.19	21.84	113
—	120	40	0.31	35.36	113
TONGSTEN LAMPS					
RATING ON LAMPS			TEST		
C.P.	VOLTS	WATTS	AMP.	WATTS	VOLTS
25	125	32	0.30	34.23	113
50	120	60	0.46	51.98	113
—	120	60	0.39	44.07	113
—	125	60	0.45	50.85	113
—	119	25	0.22	24.86	113
—	4	—	0.63	2.52	4
LOW VOLTAGE LAMPS, CARBON FILAMENT					
RATING ON LAMPS			TEST		
	VOLTS		AMP.	WATTS	VOLTS
—	14	—	0.29	4.06	14
—	10	—	0.24	2.40	10
—	8	—	0.29	2.32	8
—	15	—	0.21	3.15	15
—	12	—	0.20	2.40	12

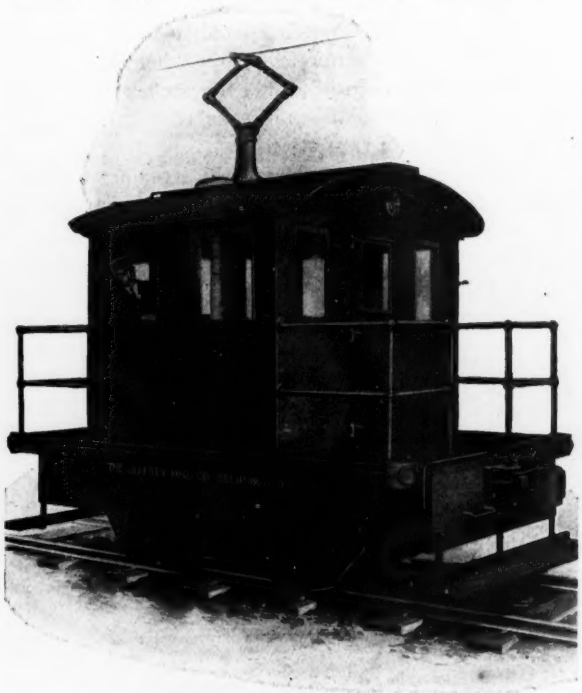
DOUBLING THE DEPTH of a chimney doubles the draft.

A METHOD OF DRAWING IN WIRES

By H. R. Rogers

PUTTING wires in a modern building after it has been completed, is not always an easy matter. The writer had an experience quite recently, however, in a building that was modern and up-to-date in every way but the wires. The building was of stone, steel and concrete and was heated and ventilated by the well known hot air and fan system, with metal lath partitions, glass floors in some of the rooms, while some were tile and others were wood covered with carpet.

Certain requests were made to put various call bells, buzzers and annunciators in various locations. Now to do this was no easy task, but to each room was an inlet duct and an outlet duct, and by this medium the writer succeeded in getting wires wherever they were demanded. The inlet duct went



JEFFREY ELECTRIC SWITCHING LOCOMOTIVE

into each room from the plenum chamber; the outlet duct went from each room to the attic; thereby the writer was enabled to string his various wires.

Taking into consideration, however, that some of these wires had to be strung through 30 and 40 ft. of horizontal duct, 6 by 12 in., and up as much as 40 ft., to get these wires through was somewhat of a problem.

A paper bag was fastened on a string of sufficient length to reach to the end of the duct, and the fan was started which was capable of producing 40,000 to 50,000 cu. ft. of air per minute; the dampers in all of the ducts were closed excepting the one through which the wires were to be strung. The writer then went into the plenum chamber and the paper bag was freed into the duct. It was found that the bag would go about 6 ft. up through the first turn. Some of these ducts had as many as 3 right angles on a 30-in. radius, and when the bag would get about 3 ft. up through the last angle, it refused to go any further. Try as we might we had no success with 1 bag.

Finally the bag was drawn back and 2 more attached to the same line about 3 ft. apart; when the first one would lodge, the second one was made to butt into it, and when the 2 would lodge, the third one succeeded in butting them out, and the bags came up; the string was secured and the wire was pulled through successfully.

AN ELECTRIC SWITCHING LOCOMOTIVE

The accompanying illustration shows a view of a 25-ton switching locomotive, built by the Jeffrey Mfg. Co., Columbus, Ohio. for use in handling freight cars for the Cerveceria Cuachtenoc brewery, of Monterey, Mexico. This style locomotive takes the same electrical equipment as the mine type, the only changes being in the side and end frames and the addition of a platform and suitable cab to accommodate the conditions incident to surface work.

The motors are of the water-proof steel frame type, having drum wound armatures, laminated pole pieces, oil lubrication, with auxiliary grease boxes and liberal wearing surfaces.

These locomotives are built in sizes from 10 to 30 tons, with 2 motors, and in larger sizes with 3 and 4 motors, arranged with rigid frame or with double trucks having flexible wheel base, depending entirely on the conditions.

CHIMNEY PROTECTION.

As a means of protecting chimneys against lightning, carbon or graphite points have been used by the Custodis Chimney Co., the Joseph Dixon Crucible Co. supplying the graphite points. This practice was first adapted in Germany and the Custodis Co. states that no instance is known of a chimney being damaged by lightning where protected by such points. The carbon points meet the requirements as stated by the electrical experts of being good conductors, not readily affected by the weather.

The method of installing lightning rods is as follows: At the top of the chimney 2 lengths of ¾-in. galvanized wrought-iron pipe are set, each secured by means of 2 galvanized wrought-iron braces built into the masonry and having clamps suitable for sustaining the pipes. These pieces of pipe are set on opposite sides of the chimney and each piece is capped with a point of retort graphite about 5 in. long and 1 in. in diameter, set into a suitable brass sleeve which is threaded to fit over the end of the pipe. A ½-in. hole is drilled into the graphite point from the lower end for a distance of 2 in. and a suitable set screw provided for clamping the point to the copper conductor proper. This conductor or cable is ½-in. in diameter, stranded, and extends from the carbon point down through the iron pipe, down the side of the chimney, being securely fastened to it, and terminates in a coil in the earth placed well below permanent moisture.

REFRIGERATION

PREPARATION OF BRINE FOR COILS AND TANKS

By Charles L. Hubbard

THERE are two kinds of brine commonly used in refrigerating work at the present time, chloride of calcium (or lime), and chloride of sodium (or salt). Either one is dissolved in water, making a solution of the proper strength for the temperature to be carried, and is then pumped from the brine tank or cooler to the objects to be refrigerated, and returned by a system of pipe, to be recooled and again circulated through the refrigerating system.

The important point to be borne in mind in the preparation of a brine is to make it of such strength or density that its freezing point will be slightly below that of the temperature of the ammonia at evaporator or suction pressure.

The freezing point of a saturated salt solution is at 0 deg. F., while that of a chloride of calcium solution of maximum density is at 45 deg. below zero. It is evident from the above that the chloride of calcium brine should always be used for very low temperatures where there would be danger of freezing if salt brine was used. The calcium brine is especially adapted for use in coolers where the brine passes through the pipes and the ammonia is evaporated on the outside at a temperature a few degrees below zero. It also has no corroding effect on pipes, pumps, or other parts of the apparatus, and while the cost is somewhat more than for salt, the general advantages are decidedly in its favor.

Salt may be safely used in the brine tank system because freezing can take place only on the outer surface of the pipes where it will cause no damage, except to act as an insulation and thus reduce the efficiency of the plant to some extent. The proper density or strength of the brine is determined by the temperature it is desired to carry; that is, its freezing point, which depends upon the density, should be slightly below the temperature of the ammonia vapor, which in turn should be about 10 deg. lower than the brine. In other words, the freezing point of the brine should be 10 or 12 deg. below the temperature at which it is to be carried under working conditions.

The strength of the brine solution is tested by a gage called a salometer. This consists of a weighted glass tube and bulb as shown in Fig. 1, which is graduated from 0 to 100. When floated in water the zero mark stands at the water level, but when placed in a saturated solution of salt brine, the stem sinks to the 100 mark. Intermediate points on the scale indicate different degrees of saturation.

Table I, for salt brine, shows the freezing point for different strengths, and the corresponding point on the salometer.

Table II is for a calcium chloride brine and is seen to vary from Table I.

Example, suppose that it was desired to carry a salt brine at a temperature of 15 deg., what strength should be used and what deg. of strength should be indicated by the salometer?

For a brine of this temperature, the freezing point should be, say 15—12=3 deg. above zero. Looking in Table I. we find that this corresponds to a solution containing 2.207 lb. of salt per gal., and would indicate a strength of 90 deg. on the salometer.

In testing the strength of brine in this manner it should first be warmed to a temperature of 60 deg., as the graduations on the salometer are for this temperature.

The general methods and conditions above de-

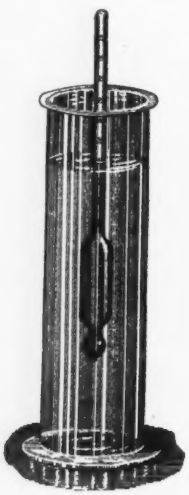


FIG. 1. SALOMETER AND FLASK

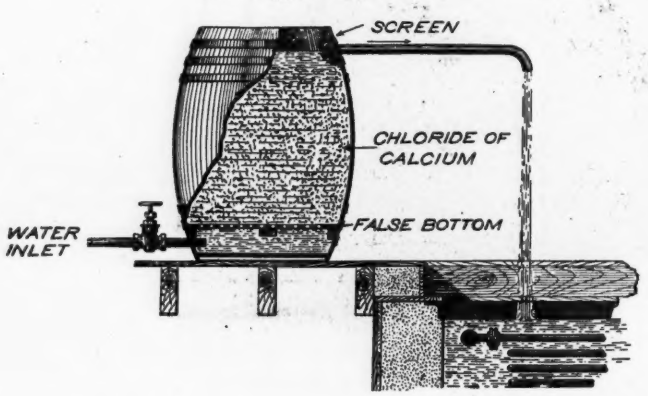


FIG. 2. ARRANGEMENT OF BRINE MIXER

scribed apply equally well to calcium chloride brine, except that Table II. should be used in this case.

The apparatus commonly used for preparing brine of either kind, and called a mixer, is shown in Fig. 2. This consists of a box or large barrel having a false bottom perforated with ½-in. holes and placed about

TABLE I. CHLORIDE OF SODIUM (SALT) BRINE

DEGREES ON SALOM.	POUNDS SALT PER GALLON	FREEZING POINT DEGREES F.
0	0	32
5	0.105	30.3
10	0.212	28.6
15	0.321	26.9
20	0.433	25.2
25	0.548	23.6
30	0.664	22
35	0.78	20.4
40	0.897	18.7
45	1.019	17.1
50	1.142	15.5
55	1.265	13.9
60	1.389	12.2
65	1.522	10.7
70	1.656	9.2
75	1.791	7.7
80	1.928	6.1
85	2.067	4.6
90	2.207	3.1
95	2.347	1.6
100	2.488	0

6 in. above the lower head. A piece of coarse canvas or sacking is placed over the false bottom and the barrel nearly filled with salt or calcium chloride as desired. Supply and overflow connections are made as shown.

The mixer should form a permanent part of the plant, and a connection should be made between the

TABLE II. CALCIUM CHLORIDE BRINE

DEGREES ON SALOMETER	LBS. OF CALCIUM CHLORIDE PER GALLON	FREEZING POINT DEGREES F.
0	0.	32.
4	0.167	31.1
8	0.333	30.33
12	0.5	29.48
16	0.667	28.58
20	0.833	27.82
24	1.	27.05
28	1.167	26.28
32	1.333	25.52
36	1.5	24.26
40	1.667	22.8
44	1.833	21.3
48	2.	19.7
52	2.167	18.1
56	2.333	16.61
60	2.5	15.14
64	2.667	13.67
68	2.833	12.2
72	3.	10.
76	3.167	7.5
80	3.333	4.6
84	3.5	1.7
88	3.667	−1.4
92	3.833	−4.8
96	4	−8.6
100	4.167	−11.6

return brine pipe from the refrigerating system and the barrel so that the brine may be passed through the mixer from time to time as may be found necessary to maintain the desired strength.

"MAKE UP YOUR MIND what you want in this life, and be determined to get it. You cannot fail if you continue to stand unflinchingly upon your original resolve. Though you do not get it as soon as you desired, there is no need of giving up. You have the power to get what you want, and you positively will get it, if you continue to go after it."

AIR-STEAM AS A MOTIVE FLUID

By H. B. MACFARLAND

THE efficiency of the perfect elementary engine depends only upon the highest and lowest temperatures between which it is worked, and is independent of the nature of the working substance.

In practice, the efficiency of all vapor engines depends upon the nature of the working fluid, and involves both the latent heat of vaporization and the specific heat.

There are a few vapor engines that use such fluids as carbondisulphide, sulphur dioxide, ether, etc., but water is the fluid almost universally used. Water when changed to steam has pressures and temperatures that conform more nearly than the others to practical con-

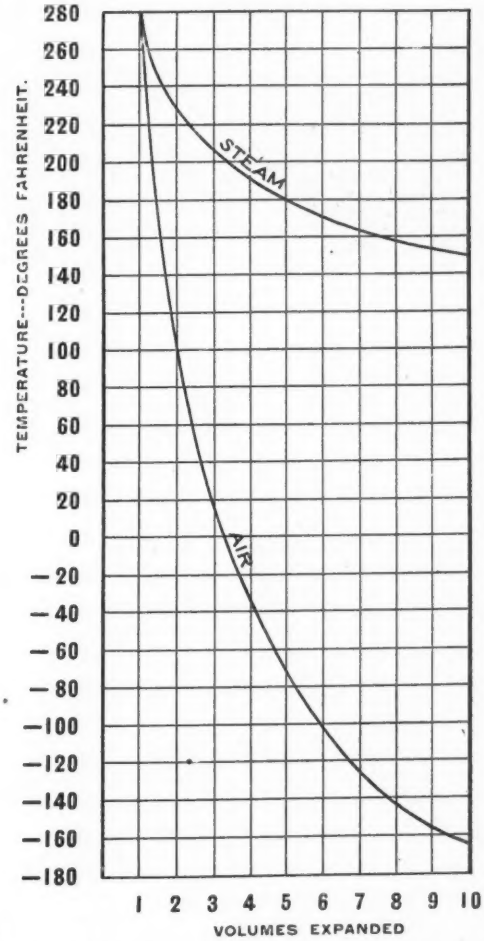


FIG. 1. EXPANSION OF STEAM AND AIR WITH RESULTING CHANGE IN TEMPERATURE

ditions of operation; that is, its pressure is not excessively high at reasonable temperatures of steam generation, and when expanded to atmospheric pressure its temperature is not excessively reduced as is the case with many of the fluids.

Compressed air is often used as a medium or working substance for operating an engine. Due to its

low specific heat compressed air has a small heat content, volume for volume, compared with steam and consequently when it expands, its temperature must be greatly lowered in order that during the expansion period it may yield heat equivalent to the work done after cutoff. In actual practice the lowering of the temperature causes the moisture, always present in the compressed air, to freeze and thereby prevents the correct operation of valves and also, by forming ice on the sides, decreases the exhaust pipe area.

The study of the 2 mediums, air and steam, is best made by comparison under the same conditions. Let

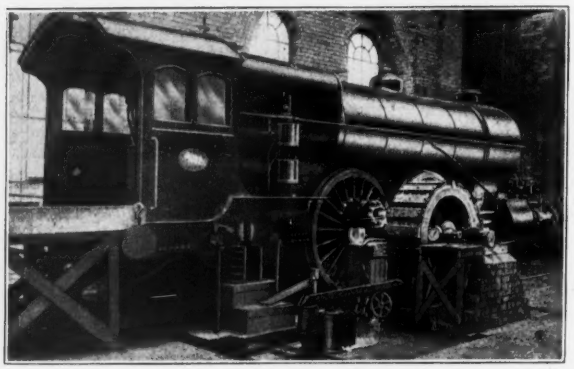


FIG. 2. EXPERIMENTAL BRITISH AIR-STEAM LOCOMOTIVE

us take 1 cu. ft. of steam at 150 lb. pressure and expand it in a cylinder of a non-conducting engine, so that no heat is lost by conduction or radiation, and in such a manner that all heat transference goes to external work; such an expansion is called adiabatic expansion of steam. Let its final pressure be 25 lb. Then take 1 cu. ft. of air at the same pressure and temperature and expand it to the same final volume. By use of the steam tables and the known laws of gases, we may deduce the following table of data:

	Steam	Air
Initial pressure, lb	150.0	150.0
Initial temperature, deg. F	358.3	358.3
Initial volume, cu. ft	1.0	1.0
Initial weight, lb	0.332	0.496
Total heat, above 32 deg. F, B.t.u.	395.5	.....
Final pressure, lb	25.0	16.4
Final temperature, deg. F	240.0	-30.2
Final volume, cu. ft	4.81	4.81
Final weight, lb	0.298	0.496
Total heat, above 32 deg. F, B.t.u.	351.3	.....
Heat to work, B.t.u	44.2	35.6
Heat to work, foot-pounds	34,388.	27,683.
Exponent for adiabatic expansion	1.14	1.41

It is seen that for the same number of expansion volumes more heat is transformed into work when steam is used than when air is used, but the final air temperature and pressure are much lower than those of the steam; this means that the air is more efficient than the steam because it expands to a lower temperature. It is also noticeable that 9 times as much heat is rejected in the uncondensed steam as is changed into work.

The relation between the drop in temperature for different expansion volumes is shown by contrast in Fig. 1. The upper curve shows the temperature drop for steam in expanding adiabatically; the lower curve is for the adiabatic expansion of air.

The natural deduction to be made from the study and comparison of the above table and curves is that, if compressed air and steam at the same temperature and pressure are mixed and then expanded, the mixture will be more efficient than when steam alone is expanded. Unfortunately the laws of expansion of a mixture of gases and vapors have not been determined

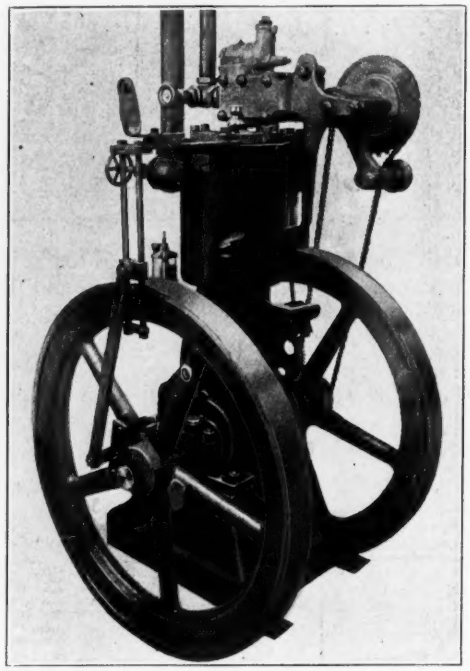


FIG. 3. 6 BY 8 IN. ENGINE USED IN AIR-STEAM EXPERIMENTS

so that one cannot calculate the temperature, pressure, and work done when a mixture expands through various volumes.

The following laws must be considered in making approximate calculations on the mixture, the volume of the gas is equal to the volume of the steam, the temperature of the gas is the same as the temperature of the steam, the pressure of the mixture is the sum of the pressure of the gas and that of the steam.

No set of equations can be given that will express the relations between the variables. It is possible to determine only the final conditions by the method of trial and error. The air in the mixture will tend to drop in temperature rapidly during expansion and there will be a transfer of heat from the steam to the air to prevent the fall in temperature. The air will act as a refrigerant and thus cause more steam to be condensed than is possible with steam expanding by itself.

A considerable amount of experimenting has been done in England and also in the United States with a mixture of air and steam for a new system of motive power.

In Fig. 2 is shown an English Locomotive under test. This locomotive has 2 cylinders in tandem, on either side. In the forward cylinder air is compressed to 200 lb. pressure, which is the steam pressure, and then delivered to a smokebox superheater where it is mixed with steam. In the rear cylinder the super-

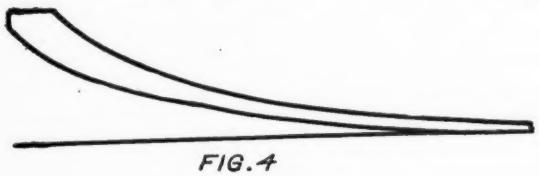


FIG. 4

FIG. 5

FIG. 6

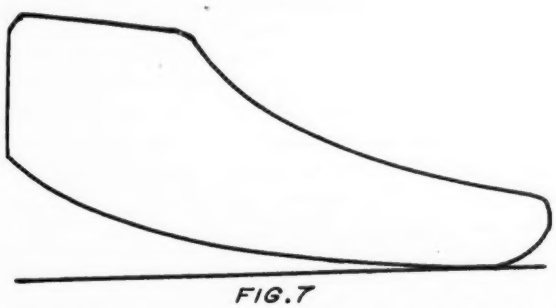


FIG. 7

FIGS 4 TO 7. INDICATOR DIAGRAMS FROM AIR-STEAM ENGINE

heated air-steam mixture is utilized as a motive agent. Exhaustive tests have been made in the shops and on the road and the results show a saving of 18 to 20 percent in fuel for a given output of energy. The experiments were made for the New Century Engine Co. of London.

In this country, experiments have been carried on with compression within the same cylinder instead of outside compression.

Figure 3 is a photograph of a 6 by 8 in. vertical gas engine which was transformed into an air-steam engine, or a four-stroke-cycle steam engine. The operation is as follows: During the down stroke air is drawn into the cylinder; upon the up stroke the air is compressed; at the end of the stroke a valve opens to allow steam to enter and mix with the compressed air; the valve closes at some point in the down stroke, after which the mixture expands until the end of the down stroke; on the second up stroke, the mixture is exhausted from the engine, after which the process is repeated in order. No attempt has been made to determine the efficiency of the engine under consideration but indicator diagrams have been taken from it.

Fig. 4 shows a card with a very early cutoff, a compression of 55 lb. and a steam pressure of 65 lb. Fig. 5 was taken with a compression of 40 lb. and a steam pressure of 85 lb. and with early cutoff. Fig. 6 was taken under the conditions of Fig. 4 but with a late cutoff. Fig. 7 shows a late cutoff with a steam pressure of 130 lb. The speed of the engine was 125 r. p. m.

The line of experiments was carried on by the Christie Engine Co. at the power plant of the street railway company, Cedar Rapids, Iowa, to demonstrate the practicability of the Christie System of Motive Power.

The chief merit of the Christie system is that it has the effect of giving a non-condensing engine all the advantages of a condensing engine without the necessity of a condenser or water for condensing purposes. The expanding air cools the steam, condenses it and decreases its pressure and temperature. The mixture of air and steam causes the steam to be superheated and the engine has the additional advantage of being supplied with initially superheated steam.

When air at 150 lb. is mixed with steam at 150 lb. the mixture will be at the same temperature as before for steam, but the air and steam pressures will each be 75 lb. The total heat of steam at 150 lb. being greater than that for 75 lb. allows intrinsic energy to be so changed that the steam will be superheated about 30 deg.

PLANS ARE BEING PERFECTED by Chas. T. Main, engineer, Boston, Mass., for the immediate development of 2 powers near Great Falls, Mont. The upper development is to be made at the falls known as Coulter's, Crooked, and Rainbow, situated about 3 miles down the river from Great Falls, where the head will be about 105 ft. A crib dam about 25 ft. high will be built with masonry head gate and waste gate structures. A steel penstock 22 ft. in diameter and about 2500 ft. long will extend from the intake to the power house, which will be of masonry, containing about 30,000 hp. of wheels and electrical apparatus.

The lower development is about 12 miles below Great Falls, where the fall is about the same as at the upper development. The dam will be of the same construction as at Rainbow Falls.

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BOILER CORROSION AS AN ELECTROCHEMICAL PHENOMENON

Iron and steel undergo deterioration and the study of this disease establishes the fact that this effect is frequently the result of electrochemical action. For a long time scientists have recognized that there are many kinds of corrosion which are revealed by microscopic examinations of the affected parts. Some investigators go so far as to state that all corrosion is the result of galvanic action.

At a meeting of the Western Society of Engineers held Jan. 15th, Professor Burgess of the University of Wisconsin read a paper and gave illustrations describing his experiments to discover to what extent this is true of boiler corrosion.

Experiments along this line have been carried on with the intention of devising methods for preventing the destruction of apparatus necessarily constructed of iron and steel which is subjected to severe strains and the action of the elements. When iron and copper are put together in an electrolyte, they form a galvanic couple and the metals go into solution. This is precisely what takes place in the corrosion of iron, the rust or iron oxide being partially or wholly deposited upon the surface of the metal.

The experiments carried on by Professor Burgess and his associates were made upon a specially constructed boiler consisting of one tube 18 in. long expanded into tube sheets at each end with asbestos packing between the tube and the sheet to form an insulator and give some means of determining the amount of galvanic force set up for various boiler waters and temperatures.

In the manufacture of boilers it is customary to use for the different parts, different metals, which seem best suited to the mechanical needs of those particular parts. A copper ferrule is generally used where the tube is expanded into the sheet, in order to give a tight joint, as already stated, the iron and copper form an electrolytic couple and it is not at all uncommon to find leaky joints in a comparatively short time after the tubes have been replaced when this construction is used and where the boiler water is such as to form a strong electrolyte.

The 2 forms of corrosion common in boilers are pitting and grooving. Pitting usually occurs along the lower sides of the tubes and the grooves in the flat surfaces of the tube sheets or shells. Experiments which have been performed have proved that such results may be obtained by electrochemical action.

In the miniature boiler experimented with, the potential and current between the tube and tube sheet were measured. As might be expected, these values were very small and necessitated the use of a galvanometer. Tests were made under varying conditions of heat and pressure, also taking time as an element, with different kinds of boiler water as an electrolyte, and the electrolytic effects of chemicals which are used as boiler compounds were compared.

Some of these chemicals caused the direction of the current to change, while others caused current in one

direction when the boiler was first heated and upon cooling down and starting again caused a reversal of the electrolytic current.

No definite law for the variation in the strength of the current has been deduced, but that electrolytic action influences greatly the corrosion of boilers has been proven beyond a doubt.

Further experiments were performed which demonstrated that strained iron, such as is found around punched holes, is more subject to corrosion than that which has not been strained.

From the experiments performed, it was reasoned that in cases where the metal was not thoroughly homogeneous, these unlike parts may form a galvanic couple which cause corrosion; this seems to be demonstrated by the streaks which appear on the surface of rusted iron.

While a number of plans for preventing corrosion in the boiler, due to electrolytic action, have been suggested, nobody has discovered one which has proved practical for industrial purposes. The introduction of false parts, that can readily be replaced, for parts where the action is greatest seems to be the most probable solution for this difficulty.

EDITORIAL CHAT

Wirelessness

Short cuts are the order of the time. We are no longer satisfied to take 10 hrs. to do a day's work, but we want to start in at 9 o'clock in the morning and be through at 3 in the afternoon, with either no time at all or not over 3¼ minutes spent for luncheon. And our good friends up in Battle Creek, Mich., say that we ought to take the short cut and cut out even the luncheon. Everything is doing by some kind of a-less process. We are getting reasonably well adjusted to wireless telegraphy, and wireless telephony is within the bounds of the possible.

For a long time Tesla has prophesied wireless transmission of power, but we have not yet reached that stage and it is questionable whether we will. As a nation we have developed a system of chewingless eating and a good many of us have arrived at the point where we wish there was such a thing as stomachless digestion. And now comes along a man who strikes a most cruel blow or he drives the first entering wedge in that development. He has devised a typewriter that works without an operator. He has not yet perfected it to the point where it will write as you talk to it, but he has it so that it will write when some other fellow talks to it, by means of telegraph keys any quantity of distance away and with no connection whatever between the two.

The principle of the device is a series of electrical contacts, one for each character on the machine, and a sending and a receiving mechanism which are driven at exactly the same rate. A contact bar passes over these contacts and as a key is struck at the sending end with the bar over the contact for that key, an electric circuit is closed, current is produced and sends out waves from a wireless device similar to that used in wireless telegraphy. At the receiving end is a receiver like the wireless telegraphy harp, which catches the impulse and carries it to the receiving bar. At that particular instant the bar is over the necessary electrical contact to work the proper key.

A certain sequence has to be followed in striking the letters, so that the system is not as rapid as the ordinary method of operating a typewriter. In an experiment made by Cecil Bembridge, who has reported the matter for the Technical World, he states that it took something less than half a minute to write "Be with you in a minute." If it takes our stenographer proportionately as long to write out this editorial there will be trouble in this office. However, she has not to write with over a half a mile of nothing between herself and the typewriter, so that is different.

It is evident that this device, if it proves commercially practical, is a step forward in our wireless progress, since it involves a more complicated series of operations than has heretofore been attempted by this method. We are prepared to welcome all advances in science and invention. We are used to sleepless nights and we have heard about profitless occupation, but we retain the hope that until the temperature changes, even though we have fireless cookery, we may not have warmthless heating.

GREAT FALLS WATER POWER DEVELOPMENTS.

Work is progressing rapidly in connection with the 72,000 horsepower developments on the upper Missouri River in the vicinity of Great Falls, Montana.

The diverting coffer dam at Rainbow Falls has been completed so that the engineering force can get into the bed of the river to make its surveys for the power house and head works, and actual construction on the dam is under way. This coffer dam is built of stone and dirt and is not intended to be absolutely tight. A second coffer dam is being built. This will be permanent, and inside of it the actual construction work is being done.

The plans for the dam and masonry work at the head gates are now complete. Those for the power station and machinery contained therein will be made later at the Boston offices of Mr. Chas. T. Main, the engineer in charge of the developments.

An engineering building has been constructed for the engineering force, containing a drafting room, living room, sleeping rooms and a bath room. This building will be steam heated and electrically lighted from a temporary plant. A spur track from the Great Northern Railroad has been built into this plant for a distance of 7,000 ft. and is ready for use.

The type of dam which has been designed is a rock-filled timber crib, covering a large area of the bed with a very wide apron. The lumber for the dam has been delivered.

At the Great Falls of the Missouri the program is practically the same as that at Rainbow Falls.

LETTERS FROM ENGINEERS

Send us descriptions of ways of doing new things, and new ways of doing old things. Rough pencil sketches and letters are all right; we will fix them up for the printer. All accepted contributions will be paid for when published.

Pump Repairs

How often we see pumps placed where it is impossible to make repairs without going to more expense than necessary, by the lack of a little forethought. The way of getting around a case of this kind may be of use to others.

A tank pump 5 ft. long was placed in a pit and held down with concrete with a space of 9 in. between the water cylinder head and the wall and 26 in. on

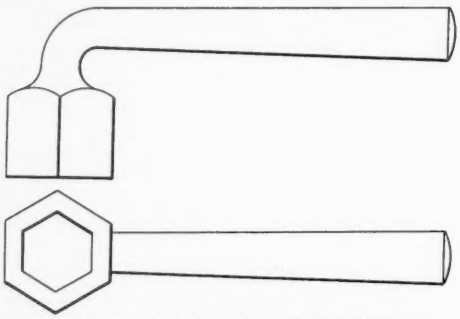


FIG. 1. OFFSET SOCKET WRENCH

the steam end. The rod in the pump was to be renewed and a new one was got before the question of getting the old one out came up, so that when the time came, there was some thinking as the pump could not be stopped more than half a day. After looking matters over, it was found that if the stuffingbox gland on the water end could be taken out, the rod would swing by the steam cylinder, so 2 socket

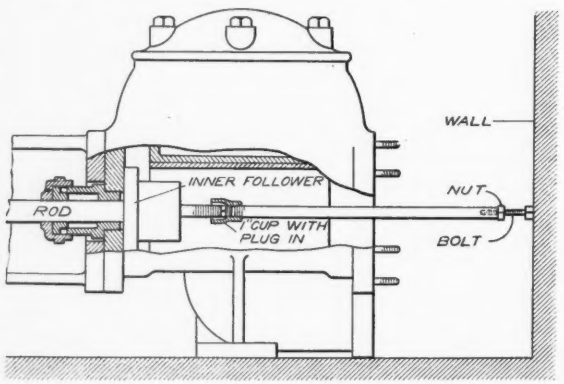


FIG. 2. REMOVING THE FOLLOWER PLATE

wrenches as shown in Fig. 1 were made, 1 for the cylinder head bolts and the other for the rod nuts. The inner follower being hard on the rod, a jack was made by taking a piece of pipe and putting a reducing coupling on, then putting a pipe plug in the coupling upside down to rest against the rod. A bolt with nut was put in the other end and rested against the wall, and by turning the nut off the bolt, the follower came off easily. Figure 3 shows how the gland

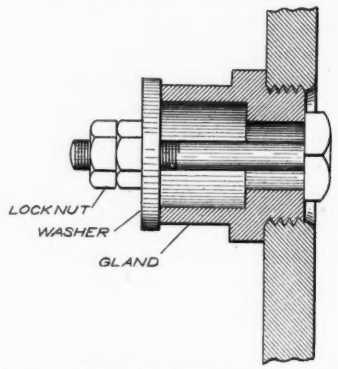


FIG. 3. PULLING OUT THE GLANDS

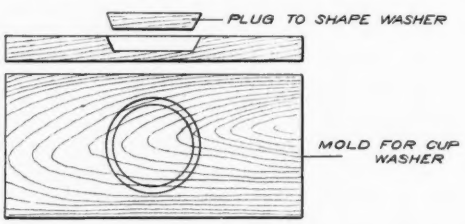


FIG. 4. DIE AND PLUG FOR THE CUP WASHERS

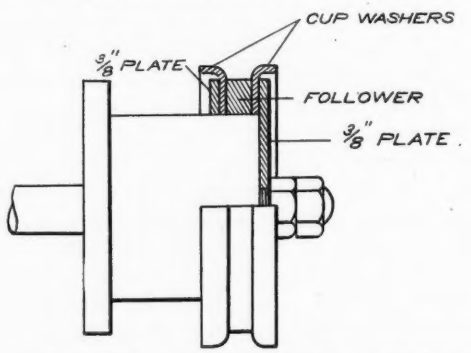


FIG. 5. ARRANGEMENT OF CUP WASHERS AND FOLLOWER IN PLACE OF PACKING

was taken out after the rod was pushed through, and the steam piston head taken off without trouble as that could be got at when out of the cylinder.

In this pump, the gland screwed in so that a bolt with a large square head was put through the gland from the inside of the cylinder and a thick washer with 2 nuts to hold it was drawn tight against the gland. By turning the inside nut, which is locked by the other, and tapping the gland, it soon came out. I

have found this one of the best ways of getting glands out and followers off, only where the gland is forced in, use a yoke.

When the gland came out it was found that the hole was not tapped square with the cylinder, which was the cause of the leaking rod and the pump not working right. As squaring the hole was harder than crossing the gland thread, the latter was done in a lathe after the amount was found by using a pine plug when centering the piston.

When the follower came off it was found that the retaining pieces that held the packing were worn out, so it was decided to use cup washers and a mold was made of plank as in Fig. 4. Some pieces of belting furnished leather and two ⅜ in. washers were made

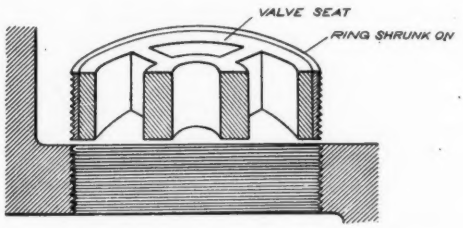


FIG. 6. RING SHRUNK ON VALVE SEAT

from plate to hold them to the cylinder wall and a nipple did for a clearance piece being put in as in Fig. 5. A nipple, ⅜-in. washer, a cup washer, then the outer follower for the cups to rest against, then cup, ⅜-in. washer, nipple and nuts. After getting the gland in as it was taken out and the head fixed, a look at the valves found some of the threads on the studs worn so that they were loose. They were heated and expanded by driving a center punch in the ends. The hole for one of the seats was worn so much out of

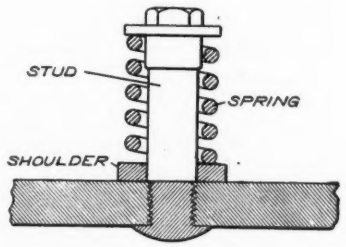


FIG. 7. SHOULDER STUD AND METHOD OF HOLDING IT

square that it had to be filed and a ring shrunk on the valve seat as shown in Fig. 6. Figure 7 is shown where the thread in the valve seat is gone, in this case a shoulder stud was made and riveted into the seat while a nut on the top adjusted the spring, and for our 4 hours trouble we got a good working pump.

D. F. Crowther.

TRANSVAAL GOLD MINES yielded during 1907 a value of $136,750,000, which, except for $5,000,000, came from the Reef on which Johannesburg is situated.

Cause and Effect

During my engineering practice I have found that by studying the cause and effect of some puzzling problem or strange acting piece of machinery, many mishaps have been avoided. After becoming acquainted with the plant you are running, the slightest change or different action should be noticed and the cause and effect ascertained.

Some time ago I was called out of bed to go to a plant where the feed pump could not be started. I knew nothing of the plant, having been inside it on only one occasion before, but upon entering the plant discovered immediately what was wrong, much to the surprise of the engineer and helper, who had taken about everything apart, examined and replaced it.

Upon opening the throttle of this pump I noticed the ease with which the handle turned, the valve opening easier than it should with 90 lb. of steam over the seat. It was plain to see that steam pressure was reaching the cylinder, although the exhaust valve was open as far as it would go. Now had I not noticed that the throttle valve opened easier than it should, I would have been in as bad a fix as my brother engineer, but this slight effect proved to me that there must be a stoppage somewhere in the exhaust so that the steam, equalizing in pressure upon each side of the valve seat, made the opening and closing of the throttle very easy. Upon taking out the bonnet of the exhaust valve, the valve seat was found disconnected and shut.

About 2 days later I was called again to the same place. Our engineer friend had put a 2-in. fire hydrant on a 6-in. main, using a saddle flange which he claimed he could not make tight. He told me had red-leaded the pipe, rubbed the saddle flange upon it to find the high spots, and filed off the same until he got a perfect fit, but after bolting it on, using a ⅛-in. gasket, it leaked. It certainly did leak, too.

My friend had made the saddle fit the 6-in. pipe, then he put a ⅛-in. gasket on the outside of the pipe and expected it to fit; you cannot make a 6-in. radius fit a 6⅛-in. radius.

In putting saddle flanges on the rough surface of pipes, etc., it is a mistake to use a full gasket; use a gasket about ⅜-in. wide and 1/16-in. thick; then you will have a small surface to crush, and make a tight joint every time.

James Browning.

A Third-Class License Quiz in Massachusetts

Below I have given a list of questions which were asked me on examination for third-class license in the state of Massachusetts which will no doubt interest some of your readers.

1. Set the valve on a slide valve engine.
2. Tell how you would go about reversing it from the way you had it set in the first place.
3. How would you reverse the engine if it were controlled by a shaft governor?

4. What is the difference between a shaft governor and a throttle governor?

5. What is the difference between a direct and an indirect valve?

6. What is a riding cutoff valve and how would you fit one?

7. If you set it to cutoff at ½-stroke on the outward stroke would it cutoff the same on the return stroke? If it did not, how would you make it?

8. If you were running a riding cutoff engine that had too much compression how would you alter it?

9. If you had an engine all stripped, had the cylinder rebored, guides planed, and a new set of boxes made, how would you know before setting it up what clearance there would be in the cylinder when it was set up again?

10. How are the valves set in a duplex pump?

11. What keeps the pistons from striking the ends of the cylinder in a pump?

12. How do you set the cushion in a pump so that you will know when you start her up that she will run all right?

13. Will a feed pump put water into a boiler at 5 lb. pressure, the pump taking steam from the same boiler?

14. If you took charge of a plant where they were heating a building with 5 lb. pressure and the returns were wasted, and the owner wanted the returns saved, what would you recommend doing if the boiler set too high to return by gravity?

15. How is a B. & W. boiler constructed, also a Stirling?

16. If you were to shut down a Stirling boiler for the winter, what would you do to prevent wasting or rusting of the boiler?

17. Suppose that you had a pop safety valve that blew at 100 lb. pressure and you wanted to reduce to 70 lb., how would you change it? Also one from 20 to 10?

18. If you had a safety valve that opened at 80 lb. and did not close tight until about 70 lb., what would cause it and what would be the remedy?

19. What is the cause of a bag in a boiler and where found?

I think that a man answering all these questions the way that the examiner wants them ought to have a third-class license. H. G. B.

(This is a good set of questions for a man to try himself out on and we would recommend their careful consideration, especially the following: Nos. 6, 7, 9, 12, 14, 16, 17 and 18. We would recommend readers to study over these and send in their answers. —Editor.)

TWO AND ONE-HALF POUNDS of good dry wood is equivalent in evaporative effect to 1 lb. of coal.

Reversed Dynamos—Feed Pipe Leak

In an electrical transmission plant here, direct current is used for both power and lighting, the power circuit being 220 volts and the lighting 110 volts. Both generators are belted to a tandem compound engine. Through the shops are motors for individual drive and for driving line shafting from 3 to 25 horsepower.

One noon the engineer shut down the engine before opening his line switches or tripping the circuit breakers. On starting up after dinner, he found that the volt and ammeters on the power board were reversed; the meters on the lighting board were all right. The engineer was somewhat scared as to what effect it might have on the motors, thinking that they would run in the opposite direction, which of course they

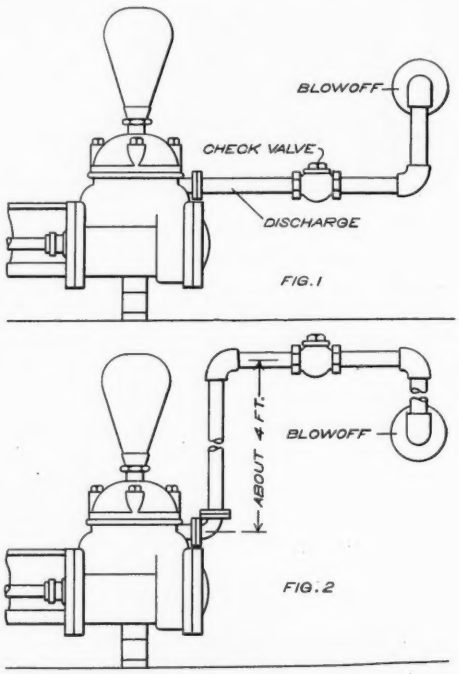


FIG. 1. FIRST PIPING OF PUMP AND BLOWOFF
FIG. 2. CORRECTED PUMP PIPING

would not do. Until the writer found out about shutting down the engine with the switches closed, he could not understand the cause. Evidently the engine had stopped before some of the larger motors did, and as the generator was compound wound, the counter e. m. f. of the motors "pumped back" through the series field of the generator and reversed the residual magnetism of the machine. The connections were changed on the meters and everything was all right.

In another plant the engineer had a great deal of trouble keeping water in the boiler over night. The discharge from the pump was connected directly to the blowoff pipe through a check valve; and the writer thought that perhaps some dirt got around from the boiler and got under the check valve and

the pump valves, and suggested a remedy: piping up from the pump and then back down to the blowoff pipe again. This was tried and the boiler has just as much water in the morning as it did the night before. No scale or dirt can get up to the check valve or down to the pump valves. O. A. R.

Repairing a Gear

In answer to some of the inquiries contained in the December issue of Practical Engineer, I would say:

For O. W. R., p. 41, the gear as a whole requires a thorough overhauling. All the bearings should be reamed out and bushed, and if too much worn to admit of that being done, then new parts should be provided, the pins should be renewed, or at least trued up, if there will be sufficient metal left on them to permit of their being used. Until this overhauling can be proceeded with, I would suggest that the present mixture of grease and graphite that he is using as a lubricant be thinned down by adding oil to it and so making it fluid enough to insure its reaching every part of all the bearings.

When the gear is rattling as complained of, give it a good dose of cylinder oil and in a few seconds the "sharpness" of the rattling will be "dulled" by the application of the oil. The oil alone would not remain long enough on the loose journals to be effective, but when mixed in with the grease and graphite so that it will not run away too soon, good results may be expected. This will at least save him much annoyance until he can get the gear overhauled as just suggested.

Answering T. C. W., p. 64, December issue, to clean brass that is very dirty or badly tarnished, use vinegar into which salt is thrown, and apply with a woolen rag, rubbing the parts briskly; to polish after having cleaned the brass work, use Putz paste, which is as good a polish for brass as is used. Putz paste can be obtained from almost all engineering supply houses.

In answer to Z. B. R., p. 64, in the same issue, while slide valves are usually designed so that either equal lead or equal cutoff can be obtained, but not so that both can be obtained, it is possible so to design that both equal lead and cutoff may be obtained.

In stationary practice it is generally considered not of sufficient importance with ordinary D slide valve engines, to design the valve for both equal cutoff and equal lead. Preference is given to equal lead when setting the valve, and the difference in the cutoff for the 2 strokes will depend upon the angularity of the connecting rod, which in turn depends upon the length of the rod. The longer the rod, in relation to the stroke of piston, the less will the points of cutoff differ, and the shorter the rod, the greater the angularity, and the greater the difference in the cutoff.

In order to overcome this, and so secure both equal lead and equal cutoff, a greater amount of lap is given the valve at the head end; the amount of such excess lap, depends upon the angularity of the connecting rod as before referred to; this is sometimes done in marine vertical engines.

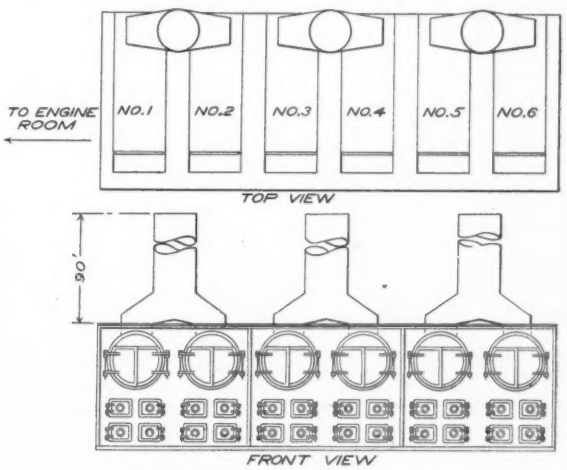
If an ordinary D valve with the same lap at both ends be set so that the cutoff occurs the same at each end, it will be found that the lead will be greater at the head end than at the crank end, but by adding more lap to the valve at the head end, and making a new adjustment to suit the additional lap, equal lead and equal cutoff for both ends can be obtained.

Charles J. Mason.

Peculiar Boiler Draft

I am sending a rough sketch showing the arrangement of 6 horizontal tubular boilers and the stacks which serve them. All 3 batteries are set as nearly alike as possible in brick setting, and are of Atlas make, rated at about 400 hp. Two boilers are connected to each stack by means of steel breechings, the stack resting on the boiler setting walls.

As seen in the figure, the engine room is on the left hand side. All the boilers are hand-fired and have



ARRANGEMENT OF BOILERS

the same kind of grates, and are alike in every respect as far as can be seen.

Number 1 does not burn very much coal and makes a great deal of clinker. Numbers 2, 3 and 5 have nearest the same draft, and as a result burn nearest the same amounts of coal. Number 4 has a good draft and burns a great amount of coal, while No. 6 has a wonderful draft and uses about twice the amount of coal that No. 1 uses. We have looked everything over time and again, but fail to find the cause for the difference. The dampers are located in the breechings just above the boilers. Can anyone give an explanation of this trouble? S. L. C.

"We are now cutting timber from the forests of the United States at the rate of 500 ft. board measure a year for every man, woman and child. In Europe they use only 60 board feet."

The Need of Study

In the September number is an article on the importance of study to engineers which, if a great many engineers would read, would be worth the price of the paper to them, as it would prove to them the practical need of education. Some engineers seem to think that what they learned 20 years ago is all they need, and do not consider that they may at any time be looking for some other plant to run where more knowledge will be called for.

Education is a good thing to possess even if you don't have to use it; it is something that cannot get away from a man and is essential in most present-day jobs.

To show how some men try to progress by taking journals, last year Practical Engineer went to a great many young engineers, some of whom made good use of what knowledge is derived from reading a paper. Some did not get any. I talked to one a little time ago about an article that was in a recent number and he said that he did not see it. He just looked at the pictures and then gave the copy to the baby to play with; perhaps it did the baby more good than it did him. Another man said that he hardly ever looked at it, so didn't find anything of interest in it. Now how would you expect to find anything of interest on the covers of a book?

Take the case of the man who had trouble with his commutator, and got four answers. Was he not more than repaid for the price of the paper by that one help? If some of the present-day firemen would read more and study the articles that engineers write from their experience and knowledge, they would not have to shovel coal all their lives; but you find men who 10 years ago were firing and are still in the same position. They seem to be satisfied to stay in the same old rut. That may be easy but it isn't profitable.

S. J. K.

Safety Valve Area

Regarding the required area of safety valve for a given boiler, a safe and certain rule would be that which would give an area large enough to discharge all the steam that the boiler could make in a given time, and would be expressed as follows: Total volume of steam in cubic inches evaporated per second, divided by the velocity in feet per second, will give the required area, both volume and velocity taken at ½ the safe working pressure of the boiler.

In the foregoing rule, volume and velocity should be taken at ½ the safe pressure for this reason, steam at a high pressure has a high velocity and a reduced volume. For instance, we will consider a boiler with a safe working pressure of 100 lb.; steam at this pressure has a volume of 259 cu. ft. per pound and a velocity of 1980 ft. a second when discharged into the air. At ½ this pressure the volume would be 437 cu. ft. and the velocity 1800 ft. a second. Now it is well known that the lift of a safety valve, or any valve of the poppet type, decreases as the pressure increases, because the velocity increases with the pressure while the volume is reduced. It is then obvious that, if the area of a safety valve is proportioned for the highest pressure that the boiler can safely carry, it would be too small with a lower pressure; for with the lower pressure it would meet with a larger volume of steam escaping at a lower velocity, consequently it would not be able to relieve the boiler as fast as steam could be made until the highest pressure was reached. From this we can see that, if a boiler of 100 lb. safe working pressure when new is equipped with a safety valve which is proportioned for that pressure, let it be by whatever rule, and the time comes, as it will, owing to age, when the pressure must be reduced far below the former limit. The safety valve would then become a source of danger.

It should be understood that when using the above formula for safety valve area, the evaporation should be based upon the highest capacity of the boiler. A badly proportioned safety valve, whether too large or too small, is always attended with a certain amount of danger.

E. C. Allen.

A Peculiar Diagram Feature

I have read your paper for 3 years and enjoy reading it, looking forward every month for what I can learn. I enclose a set of cards which was taken from my engine, a Bates-Corliss, 16 by 36-in., running at

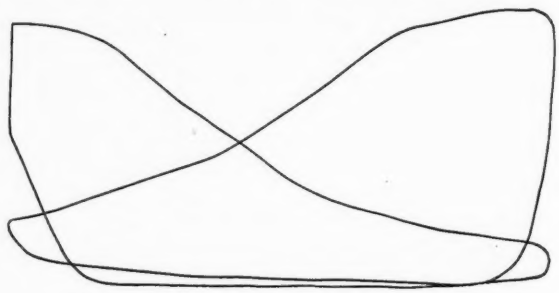


FIG. 1. DIAGRAMS AT MEDIUM LOAD

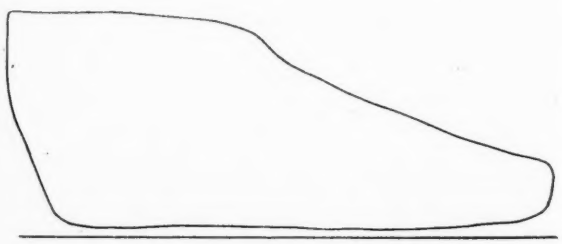


FIG. 2. DIAGRAM AT HEAVY LOAD

90 r. p. m. and with very uneven load. I would be glad of a discussion on these cards and particularly on the expansion line, which seems to show a peculiar flatness.

E. E. Barclay.

WHEN THE PULSATION OF AN ENGINE can be seen in the boiler, the latter is too small for its work.

SAVING DUE TO FEED WATER HEATING

BY J. B. SPENCER

I ATTENDED the convention last fall at Denver of the National Association of Stationary Engineers, and among other stories I heard one that is of practical interest to all works managers as well as operating chief engineers. One of the engineers attending the convention was a chief of one of the large mine power plants, and he told us this rather interesting account of how he had made good with the management by applying his knowledge of economical power plant operation, with the result of saving them many dollars per year.

This man, a member of the N. A. S. E., was getting $6 per day as engineer of a 600-hp. plant, when the prevailing rate of pay to engineers in his locality was only $3.50 to $4.

His success was not due merely to his skill as a mechanic, but came from the fact that he understood

TABLE I. COST OF FEED-WATER HEATERS

Discount — 40% off — *PRICE LIST*

Type	No.	Horsepower	Price	Type	No.	Horsepower	Price
A	1	45	$100	C	15	1050	$1125
A	1-A	70	130	C	18	1200	1275
B	2	90	160	C	19	1300	1350
B	2-A	135	210	C	24	1600	1500
B	3	200	280	C	28	2000	1900
B	4	265	325	C	32	2200	2050
C	5	325	400	D	40	2750	2300
C	6	400	500	D	48	3300	2800
C	8	540	600	D	54	3700	3200
C	10	675	740	D	62	4250	3700
C	13	900	950	D	70	4800	4000
				D	85	5850	5400

economical plant operation, ascertained where he could save in operating costs, and going to the owners, convinced them that he knew his business and got them to make the changes that he suggested.

The addition asked for was a good feedwater heater. At the end of the year the manager came to this engineer and said:

"Tom, we've saved $2,400 in our coal bills this year. I guess, after all, that heater you bullied me into buying wasn't a bad investment. It cost me just $380, and I guess we can credit profit account with about $2,000 to the good this year. It is like finding money."

"Finding money, eh? I told you what it would save, and I guess that I wasn't very far wrong, either, was I? It is a pure engineering problem, and when I made the suggestion to you I was pretty sure of my figures. Don't you think that a part of that saving might be put to my credit account instead of to profit and loss, Mr. ———?"

He got his raise, and justly so.

In this story I have had to use fictitious names, since I do not have the engineer's permission to print it.

The value of feed-water heating is well understood in its general advantages, but the interest in this story lies in the ability of this engineer to estimate accurately in dollars and cents how profitable the investment would be.

Since this is a subject that should interest all engineers and managers, unless they are already thoroughly posted, I shall give an explanation of how the amount of this saving may be foretold.

In order that the value of a feed-water heater as an investment may be definitely determined, it is, of course, necessary to know the cost of a heater that will effect the saving that has been computed, and therefore I print a list of prices which is based upon the

TABLE II. SAVINGS FROM USING FEED-WATER HEATERS

Type of Engine and Type of Plant	Working hours per day. — Working days per year	Coal in pounds burned per 100 I. H. P. per day	Cost per ton of Coal in Bunkers	Amount in dollars saved per year per 100 I. H. P., by heating water to final temperature of 210° F., from initial temperatures of 40,° 60°, 80.° etc. 40° F.	60° F.	80° F.	100° F.	120° F.	130° F.	140° F.	160° F.
Simple High Speed Engine in Office Building at 5 lbs. Coal per I. H. P. per hr.	10 hours per day — 310 days per year	5000	**2.50**	256	231	203	176	146	131	116	85
			3.00	308	277	244	211	175	158	139	102
			3.50	359	323	285	246	204	184	162	118
			4.00	410	370	325	281	233	210	186	135
	24 hours per day — 310 days per year	12000	**2.50**	615	555	488	422	352	316	278	203
			3.00	738	667	587	507	422	380	335	244
			3.50	861	778	683	591	493	443	390	285
			4.00	985	889	782	676	563	506	446	325
Factory or Mill Service at 4 lbs. Coal per I. H. P. per hr.	10 hours per day — 310 days per year	4000	**2.50**	205	185	163	148	117	105	93	67
			3.00	246	222	195	178	140	126	112	81
			3.50	287	259	228	207	164	148	130	94
			4.00	328	296	261	237	187	169	149	108
	24 hours per day — 310 days per year	9600	**2.50**	492	443	390	337	280	252	222	162
			3.00	590	537	468	404	336	303	267	194
			3.50	688	620	546	472	392	353	311	227
			4.00	785	709	624	539	448	404	356	259
Large Power Plant at 3 lbs. Coal per I. H. P. per hr.	10 hours per day — 310 days per year	3000	**2.50**	154	139	122	105	88	79	69	50
			3.00	184	167	146	126	105	94	83	61
			3.50	215	194	171	147	123	110	97	71
			4.00	245	222	195	168	140	126	111	81
	24 hours per day — 310 days per year	7200	**2.50**	368	332	293	253	210	190	167	121
			3.00	443	398	352	303	252	227	200	146
			3.50	517	464	410	354	294	265	234	170
			4.00	590	531	469	405	336	303	267	194
Compound Cond. Engines Large Central Sta. at 2½ lbs. per I. H. P. per hr.	24 hours per day — 360 days per year	6000	**2.50**	357	322	283	244	204	183	161	118
			3.00	428	386	339	292	244	219	194	141
			3.50	499	451	396	342	285	256	226	165
			4.00	570	515	452	391	326	293	258	188
The Same, at 2 lbs. per I. H. P. per hr.	24 hours per day — 360 days per year	4800	**2.50**	285	257	227	196	163	146	129	94
			3.00	343	309	272	235	195	175	155	113
			3.50	400	360	318	274	228	205	181	132
			4.00	457	412	363	313	261	234	207	151
Marine Compound Condensing, including Auxiliary Engines, at 3 lbs. Coal per I. H. P. per hr.	24 hours per day — 280 days per year	7200	**2.00**	267	240	211	183	152	137	125	88
			2.50	334	300	264	229	190	171	156	110
			2.75	367	330	291	252	209	188	172	121
			3.00	400	360	317	275	228	206	187	132
Marine Triple Condensing, including Auxiliary Engines at 2¼ lbs. per I. H. P. per hr.	24 hours per day — 280 days per year	5400	**2.00**	200	180	159	138	114	101	91	66
			2.50	250	225	198	172	142	126	114	82
			2.75	275	248	218	190	157	140	125	91
			3.00	300	270	238	207	171	152	137	99

market quotations of several of the first-class feedwater heaters. It will be understood, of course, that the prices will vary with different makes of heater and will depend somewhat upon selling expenses, such as agents, traveling and other expenses.

By special courtesy of the Griscom-Spencer Co., which manufactures the Reilly Multicoil heater, I have been allowed to reprint a table from their catalogue, giving the amounts, already figured out in dollars and cents, of the yearly cash savings resulting from the use of feed-water heaters in plants of various sizes and types.

This table will save a great deal of trouble in computing the saving, but I shall also give the accurate method of figuring this and shall take as an example the mine power plant regarding which I told the above story and in which the manager said the saving had been $2,400 per year.

This boiler plant consisted of 4 150-hp. return tubular boilers. The steam was used in a mill engine

for driving the shafting, hoists, etc., in the stamp mill, in an electric generator for furnishing power and lighting for several mines which used this plant as a central station, and in 2 air compressors which furnished air for the same mines. I do not know just what the sizes of these various units were, but for any specific case of your own you can ascertain these facts definitely and also find out the probable load factors. In this plant they had to keep pushing their boilers pretty steadily, though, and we will estimate that they operated for 10 hr. a day, for 310 days a year, and at an average of 5/6 of their total normal capacity—that is, 5/6 of 600, equal to 500 boiler horsepower.

With the run of mine coal used at this plant they could make about 7.15 lb. of steam per pound of coal, so that for 500 boiler horsepower at 30 lb. of steam per horsepower per hour there would have to be burned $\frac{500 \times 30 \times 10}{7.5 \times 2240} = 8.93$ tons a day. We will call this 9 tons a day. Coal delivered at the railroad at this mining camp cost $4.50 a ton, and hauling to the plant $1.50 a ton more, making the total cost in the bunkers $6 a ton. The daily coal cost was therefore $54. This price of coal is, of course, high as compared with the general rate throughout the country, and for this reason may make a poor example. The table given above, however, is figured for coal varying in price from $2.50 to $4 a ton in the bunkers, also in 2 cases for as low as $2.

Now, we will assume that before the installation of the feed-water heater the average temperature throughout the year of the water fed to the boilers was 50 deg. F., and that after passing through the heater it was raised to 200 deg. F. This means that 150 deg. of heat was saved, taken from the waste heat of the exhaust steam instead of from the coal burned under the boiler.

The total amount of heat required to make 1 lb. of steam at 100 lb. pressure from 1 lb. of water at 50 deg. F. may be found from the table of the Properties of Saturated Steam, which is given in all engineering handbooks. The amount is made up of 2 quantities; that is, the heat required to raise the water from 50 deg. to 337 deg., which is the temperature of the steam as given in the tables, plus the latent heat of vaporization, also found in the tables. In this case this would be 287 B. t. u., plus 875 B. t. u., or a total of 1,162 thermal units per pound of steam generated.

But the saving by preheating the water 150 deg. is 150 B. t. u. per pound, and this is therefore a saving of $\frac{150}{1162} = 12.9$ per cent of the total coal required by the boiler before the installation of the heater.

It must be understood that this saving is absolute and positive. In practice it will be exceeded somewhat because of the slightly increased efficiency of the boiler which results from feeding hot instead of cold water to the boiler.

Reducing this saving of 12.9 per cent to cash value during a year's run, we find that it is $0.129 \times \$54 \times 310$ days, or $2,160 a year.

We can see, therefore, that the manager who said that he had saved $2,400 in his plant was probably not far wrong, because if our assumption of his load factor and the evaporation of 7.5 pounds of steam per pound of coal was correct, he could not have saved less than $2,160.

In addition to this direct cash saving that is easily seen from the coal bills and is proved by mathematics, there are other advantages to be had from the feed-water heater, namely, purification of the feed water from scale, increased maximum boiler capacity, saving in cost of the boiler maintenance, and increased life of the boiler.

The value and amounts of these savings and advantages are perhaps better appreciated by the practical operating engineer than by the theorist and mathematician, but they are positive and important.

THE HELANDER BAROMETRIC CONDENSER

The barometric type of condensers make use of the weight of the condensing water and condensation from the exhaust to drain the condensing chamber. This chamber is placed 30 or more feet above the level of the water in the hot well, which is sufficient under ordinary pressure to maintain a vacuum above the level of the water in the discharge pipe. The action of this type of condenser will be understood from the illustration given in Fig. 1.

The Helander Barometric condenser, which is manfactured by the Mesta Machine Co. of Pittsburg, is built entirely of cast iron, hence, is little affected by acids or oily water. By the practical and peculiar internal design and construction of this condenser, the noncondensable vapors are removed by an air pump when their temperature is approximately that of the cold injection water. At this point the density of the vapors is at a maximum and the volume a minimum, thus permitting the use of a small air pump.

The head against which the condensing water is pumped is not equal to the difference in the level between the cold well and the injection nozzle of the condenser, as would first appear, but this is diminished by the height of the barometric column in the condenser. The operating principle of the condenser thus relieves the pump of about 29 ft. of its head for a vacuum of 26 in.

This condenser is built in 2 types, A and B, type A being shown in the illustrations. This type is used with either a basement or overhead exhaust line, but is particularly adapted to the latter condition. Type B, on the other hand, is especially designed for use with basement exhaust lines, such as are found with horizontal engines and turbines. The high vacuum condition usually demanded for turbine work makes it advisable to give as direct a path as possible for the

steam, which is accomplished in type B by using the exhaust steam line as the support for the condenser, thus dispensing at the condenser entrance with the elbow, necessary if type A be used with the basement exhaust line. The steam nozzle in this pipe is fitted with a carefully designed baffle, which prevents the possibility of the cooling water flowing down the exhaust pipe.

The only material difference in these 2 types is the direction of the entering exhaust steam lines and the method of support. With these exceptions, the interior arrangement of both types is as shown in Fig. 2. A large number of water pools between the point of steam inlet and the top of the vessel where the air is extracted, keeps down the temperature of the cooling water, which is a necessary feature in a condenser of this class. Large surface contact for water and steam is afforded by a series of waterfalls, thus insuring thorough intermingling and rapid condensation.

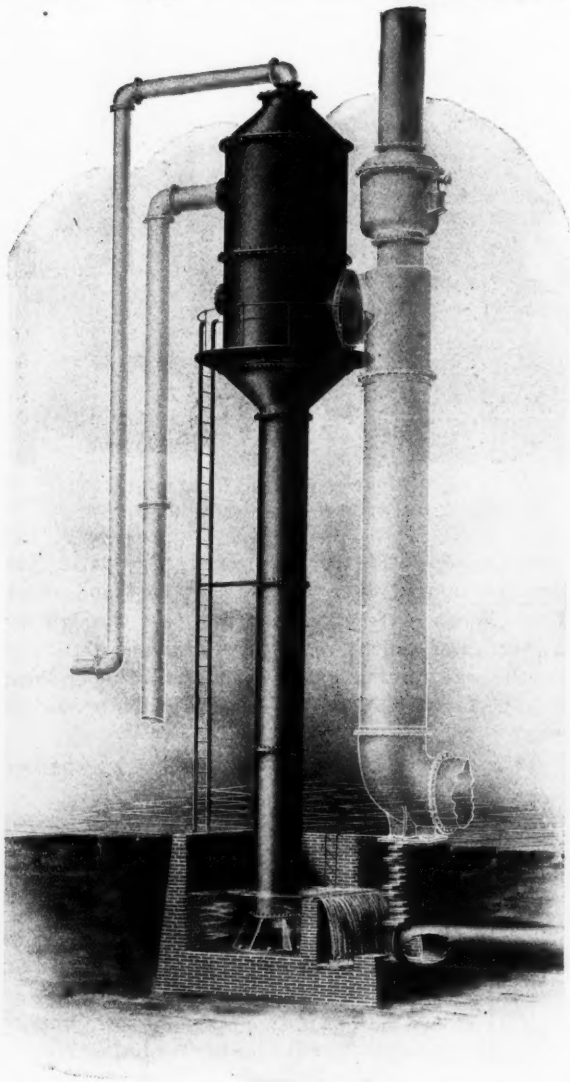


FIG. 1. HELANDER BAROMETRIC CONDENSER

It is customary in condensing practice to install some kind of a relief valve, which is designed to open automatically, if at any time the vacuum be lost and the pressure in the condenser rises above that of the atmosphere. At times when the pressure conditions within and without the condenser are equally balanced, the valve is apt to chatter, rapid wear results and the ability of the valve to seal the vacuum is lost. To overcome this difficulty, this company has designed a new type of relief valve, which in no way depends upon a mechanically tight joint to seal the vacuum. This valve is placed at the foot of the barometric column and automatically comes into action when the vacuum is lost, and the barometric column of water falls to the hot water level. The steam thus passes down the overflow pipe and out through this valve from which it is piped to any convenient point.

The large condensers are equipped with either a slide valve or Corliss valve rotative dry-air pump, which is of a strong design and gives reliable operation, coupled with low steam consumption. With the smaller condensers, where the total amount of steam used by the auxiliary machinery is small, the slide-valve air pump shows the better results and is usually furnished.

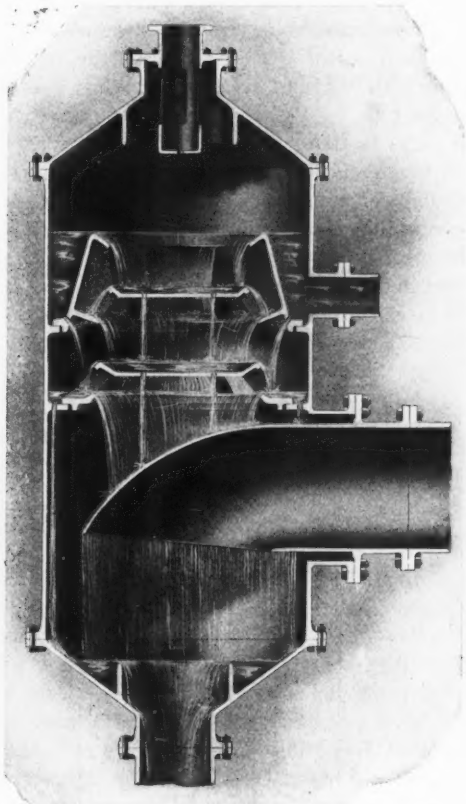


FIG. 2. VERTICAL CROSS SECTION OF CONDENSER VESSEL

MOTOR STREET CLEANING MACHINES are the latest experiment with the self-propelled vehicle in Paris.

ERWOOD STRAIGHTWAY SWING GATE VALVE

Walch & Wyeth of Chicago are the manufacturers of the Erwood Straightway Swing Gate Valve, which is a combination of a gate and check valve, and is adaptable to a large variety of uses.

In appearance, as will be noted in Fig. 1, this valve resembles the ordinary gate valve with the exception that a spring and arm are attached to the side. The pressure of the spring may be varied to any desired amount by means of the adjusting nut. The action of the swing gate is controlled by the tension of the spring, which is regulated according to the pressure desired.

Figure 2 is a sectional view of this valve, which shows the disk to be pivoted to a riser and held in place against the valve seat by the pressure of an arm bearing on the back of the disk. The disk and seat faces are flat and made of brass.

When the valve is in the open position, it presents the features of the ordinary straightway valve and is frequently used as such. In the extreme open position, the riser forms a tight joint at the top of the hood, which allows it to be repacked while pressure is still on the pipe.

The valve is frequently used as an ordinary back-pressure valve and as such it is noiseless in operation, and, not depending upon gravity for its operation, may be placed in any position in the pipe line. The adjustment is not disturbed by throwing the valve in or out of service, which is done by operating the handwheel. The flat faces of the valve make it self-cleaning, as the sediment is wiped off when the valve is opened.

arrangement is perfectly automatic and requires no attention from the engineer.

Another use to which this valve is adapted is that of a check valve for water lines and it presents an additional feature which permits reversal of the current under pressure, which is impossible in the ordinary check valve. It is designed for use in feed pipes, suction lines and as a check and gate generally. In heavy suction service, where it is very important that

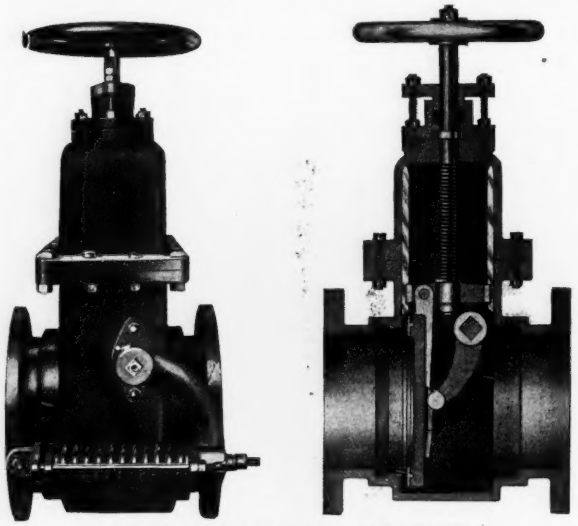


FIG. 1. ERWOOD SWING GATE VALVE
FIG. 2. SECTIONAL VIEW ERWOOD VALVE

continuous operation be maintained, the valve has many advantages over the ordinary foot and check valve. When obstructions and dirt pass through the strainer, these can be removed by drawing the valve over the seat into the bonnet, which will wipe or shear off any foreign matter or sticks which prevent its closing.

As a shutout gate where a number of engines,

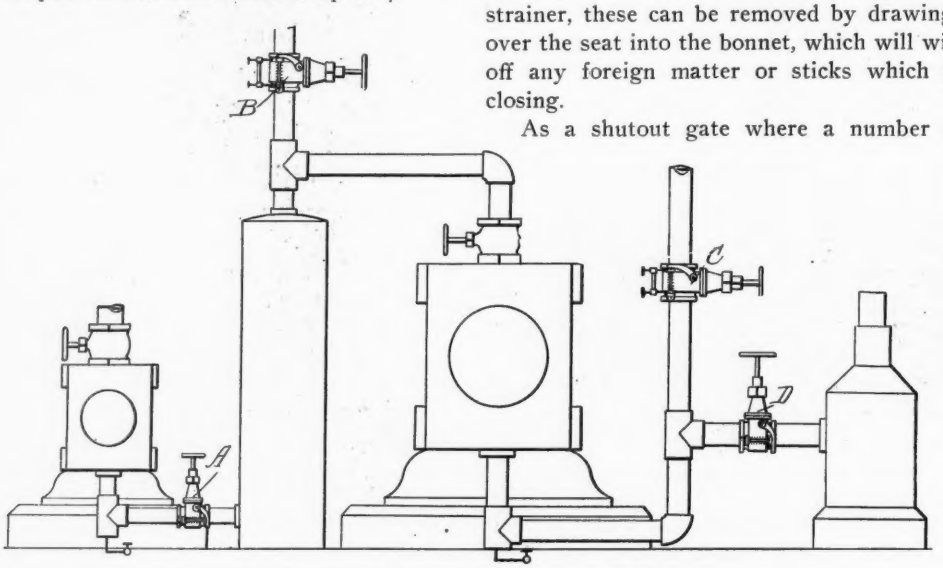


FIG. 3. ERWOOD VALVE IN CONDENSING SERVICE

This valve is peculiarly adapted for use as an automatic relief for condensing and turbine engines, being fitted with a gage glass and ball cock feed from the circulating or feed pump and is fully submerged. This pumps, steam hammers, etc., exhaust into the same main, it is valuable as a safe-guard, preventing accident by water in places where the engines should be started before the gate is opened. The cylinder can-

not be filled with water backing up from other units and they can be warmed up and started first before the exhaust gate is opened.

Figure 3 illustrates the use of the Erwood valve in compound condensing service, permitting either cylinder to be operated singly or cross-condensing or non-condensing. A is an Erwood shutout from the receiver closing against the atmosphere. C shows the valve used as an automatic relief; also closing against the atmosphere between the low-pressure cylinder and condenser. The valve shown at D works as a swing gate, shutting against the condenser. In this instance B and C should be fitted with gage trimming and the valve flooded.

The application of the Erwood swing gate in open heater connections, as shown in Fig. 4, will attract attention, as it removes all danger to any engine connected to exhaust through or into an open heater. A

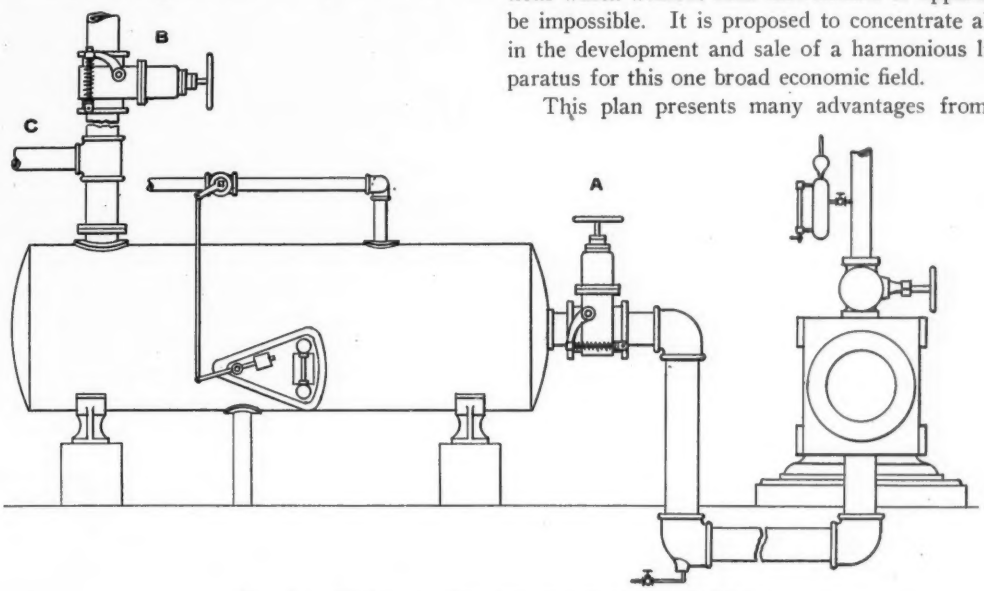


FIG. 4. ERWOOD VALVE USED WITH OPEN HEATER

is the valve connected to the open heater through which passes all or part of the exhaust of an engine. It is kept closed at all times and thus prevents the water from a flooded heater from backing up into the engine and wrecking it. Thus by employing this valve admirers of this useful form of heater can use it with impunity, for the engine can then be started up without danger when the heater is flooded with cold water. The valve shown at B on the exhaust riser is used to maintain the desired back pressure in the heating lines connected through the branch C.

There are many other uses to which this valve is adapted and its extreme simplicity insures for it a wide use in power plant practice.

CAST-IRON FLYWHEELS should, if possible, not be given a greater speed than 80 feet per second and a mile a minute is considered the limit as to speed.

THE INDUSTRIAL INSTRUMENT CO.

This was organized by men who have long been engaged in the manufacture of measuring instruments. the leaders being Messrs. B. B. Bristol, E. H. Bristol, and W. E. Goodyear, all of Waterbury, Connecticut, who for years were active in the development of the Bristol Co., and in the direction of its affairs during the time of its greatest development and success.

The Messrs. Bristol, who were among the original incorporators of the Bristol Co., with several of their coworkers, withdrew from that company last spring, to develop a plan of larger scope and broader aims than was possible in that organization. Their plan involves the design of an extensive line of those types of measuring instruments and apparatus, the use of which promotes directly or indirectly, safety and economy of operation in industrial plants, and oftentimes makes possible operations which without such instruments or apparatus would be impossible. It is proposed to concentrate all energies in the development and sale of a harmonious line of apparatus for this one broad economic field.

This plan presents many advantages from the customer's standpoint in that he is able to secure a certain distinct class of apparatus from one house, knowing that the component parts will harmonize, and that he has obtained a well co-ordinated equipment designed to accomplish a certain result. He is relieved of the inconvenience of securing parts of an equipment from different makers and of the responsibility and forethought necessary to insure their successful operation as a whole.

From the vendor's standpoint it is, of course, an advantage to have a certain class of customers, whose problems it is impossible to study, so that their peculiar requirements in a certain direction may be met to a nicety.

Lastly, manufacturers' efficiency is attained through the use of the same equipment for the production of several closely related articles rather than the employment of different equipment for each.

The Industrial Instrument Co., which was formed to achieve the above purposes, is a Connecticut corporation,

with authorized capital stock of $2,000,000. This company now owns the entire capital stock of the Standard Gauge Mfg. Co., until recently of Syracuse, N. Y., and of the Standard Electric Time Co., of Waterbury.

The Standard Gauge Mfg. Co. will be reincorporated in Connecticut. It has purchased a plant at Foxboro, Mass., into which it has moved from its outgrown quarters at Syracuse.

The personnel of the organization includes instrument engineers of long experience, so that its engineering staff is capable of meeting successfully demands for apparatus of a special nature for particular conditions so long as it falls within the company's scope.

This engineering staff will continually be engaged in the development of those types of instruments necessary to complete the line planned by it.

The sales end of the business will be carried on by the Industrial Instrument Co., of New York, which has recently been formed for this purpose. This Company will handle the entire output of the Standard Gauge Mfg. Co., and also the industrial branch of the business of the Standard Electric Time Co.

Its officers are: President, Bennet B. Bristol, formerly secretary and treasurer of the Bristol Co.; Vice-President, Walter W. Patrick, until recently manager of the New York office of the Bristol Co.; Secretary, Henry P. Dennis, formerly manager of Chicago office of the Bristol Co.; Treasurer, Arthur F. Mundy, secretary and general manager of the Standard Gauge Mfg. Co.

It is the intention of the company to place on the market instruments as fast as they can be perfected and developed to a point where they can be considered worthy of the confidence and support of the engineering world.

The broad purposes, solid principles, personnel, experience and financial strength of this unique instrument company seems to indicate for it a future of great progress and usefulness along its chosen line of activity.

The Home Office will be located at Foxboro, Mass., with Sales Offices at 50 Church St., Hudson Terminal, New York, and 752 Monadnock Bldg., Chicago.

LINING UP AN ENGINE

The method which is given below for lining up a horizontal engine will apply either to an old engine which has been taken apart for repairs, or to a new one which is being installed. It is assumed that the foundation is in place and the bedplate securely fastened to it, in the proper position, by means of anchor bolts. It is further assumed that the cylinder is secured to the bedplate in its proper position, which

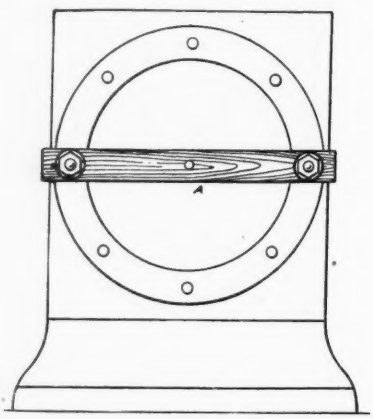


FIG. 1. FINDING THE CENTER LINE OF THE ENGINE

would be the case with a new engine, as this operation is done in the shop before shipment.

When it is desired to line up an old engine, it is necessary to remove the cylinder head, piston, piston rod, connecting rod and cross head. The next step is to adjust the center lines.

Getting the Center Line

There are many ways in which to find the center line of a cylinder, but the following is one of the easiest and quickest, and one which can be understood by anybody in charge of the work. A narrow strip of wood is placed across the flange of the cylinder at the head end and secured there by 2 opposite studs, as shown at A in Fig. 1. The center of the cylinder is found by means of a rule, and a hole about 1 in. in diameter is bored at this point.

A standard is then set up at the crank end of the engine bedplate, as shown in Fig. 2, and a hole bored in it at the height of the center of the cylinder. A fine

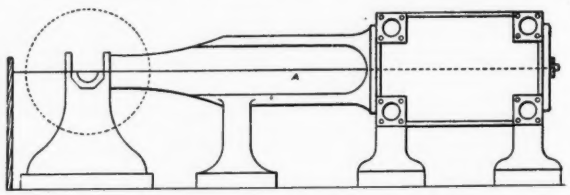


FIG. 2. FINDING THE CENTER LINE OF THE CYLINDER

line or wire is run through the hole in the strip, stuffing box and the hole in the standard. It is then drawn tight and fastened at each end to a stick about 2.5 in. long, in such a manner as to allow easy adjustment of the line. Two pieces of tin may be used in place of the sticks and the line fastened to them by passing it through small holes in the tin and tying knots to prevent it from slipping through. This line or wire should be strong and drawn tight enough to prevent any sag due to its own weight.

The line is then made central at the head end of the cylinder by the use of inside calipers or a stick cut to the exact length of 0.5 the diameter of the cylinder in the counterbore. In order that this adjustment may be accurate, at least 4 measurements at right angles to each other should be made, and the stick or tin, to

which the line is fastened, shifted to the proper position.

The line should then be tested at the stuffing-box end of the cylinder and be adjusted to the proper position by shifting the fastening at the standard end. These adjustments should be repeated alternately several times in order to insure accurate results.

This line is shown at A in Figs. 2 and 3 and is the center line of the engine, and all other parts of the

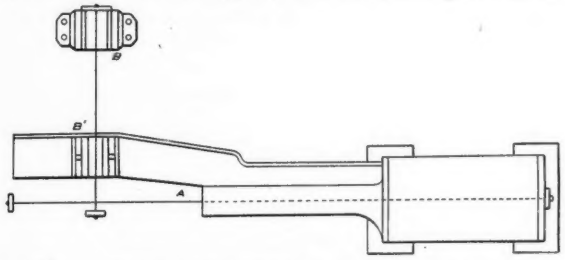


FIG. 3. ADJUSTING THE CENTER LINE OF SHAFT TO THE CENTER LINE OF THE ENGINE

engine have to be adjusted to agree with it. It should, of course, be perfectly level, presupposing that the foundation and bedplate are level.

Locating the Shaft

Having established the center line of the engine, the next step is to find the center line of the shaft, which is shown at B in Fig. 3. This line must be level and perpendicular to the line A. When the shaft is in position it is impossible to stretch the line B, therefore the shaft is made perfectly horizontal by means of a spirit level and perpendicular to the line A by the following method: The crank pin at the middle point of its length should cross the line A, as shown in Fig. 4. The shaft is then turned 180 deg., and here again line A should cross the crank pin at its middle point. If this is the case the shaft is perpendicular to the line A, provided the crank is properly mounted on the shaft.

In large engines the bearing B, Fig. 3, is movable to a certain extent with respect to the one at the crank end, which is usually cast solid with the bedplate. We will now consider that the shaft is in place and it is necessary to run the line B. Two standards are erected for this line, the top brasses and caps of the bearings should be in place, and the line B passed through the center of the bearings. The line is stretched through the bearing B and centered by means of calipers or 2 blocks of wood cut to fit the bore of the bearing. It is next necessary to square the line B with the center line of the engine. This is done approximately with the ordinary carpenter's framing square, keeping in mind that the line A must not be changed and that the line B must coincide with the center line of the innermost bearing.

With large engines the above method is not sufficiently accurate to give good results, and the 2 following methods are given by which most accurate adjustment may be obtained. A stick 8 or 10 ft. long is pointed at the ends and marked at its exact center. This center mark is placed at the crossing of the lines A and B, and the positions of the points are marked upon the line A. One end of the stick is then placed on one of the marks on the line A and the other upon the line B, and this latter position marked. The stick is then placed with one end at the second mark on the line A and the position of the other end marked on the line B. If this latter point coincides with the one previously obtained, the line B is perpendicular to A and will need no further adjustment.

The other method is founded upon geometrical principles, and consists in measuring from the intersection of the 2 lines the distances 6 and 8 feet, respectively, on the lines A and B. Between the points thus obtained the distance in a straight line should be 10 feet. If this is not the case, the line B should be adjusted until this condition is obtained. It is not necessary to use these exact figures, as this is merely a problem in finding the hypotenuse of a right angle triangle and may be adapted to any desired dimensions.

The next step is to level the line B. This may be done by the use of a spirit level or a plumb line and square, or by means of the plumb line and hypotenuse method which is given above, the latter being prefer-

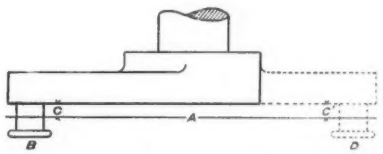


FIG. 4. LINING UP THE MIDDLE POINT OF THE CRANKPIN WITH THE CENTER LINE OF THE SHAFT

able, as it will give more accurate results.

After this has been done, it is well to verify the relative alignment of the lines, and with reasonable care a degree of accuracy suitable for practical purposes can be obtained. With a new engine, or one with new shaft bearing brasses, the center line of the shaft is placed 1/32 in. above the line A to allow for wear in the bearings.

After the alignment of the lines A and B is verified, the bearing B is shifted until the center coincides with the line B, in which position it is securely fastened.

Lining the Guides.

The alignment of the guides is tested by means of a spirit level to ascertain whether they are in the proper plane with respect to the line B. They should then be adjusted with respect to the line A, which is the center line of the cylinder, by using a steel square, being careful to have each end the same distance from A, placing it alternately at one end and then the other of the guides and at right angles to them. If the measurement from the lower edge down to the line B is the same at either end of the guides, they will necessarily be in line vertically.

If the measurements do not correspond, then the same end of both guides must be raised or lowered

until the distances are the same. Measuring the inside edge of the guides to the line A will show whether the guides are parallel to it, and consequently parallel to the center line of the cylinder. To test the guides as to being in the same horizontal plane, a spirit level is placed squarely across the guides at the ends successively.

Fitting the Bearings

When the guides are adjusted, the line B may be removed and the crankshaft, crank and flywheel put into place. Care should be taken in this operation to prevent the line A from being moved out of adjustment, as the correctness of the rest of the work depends upon the position of this line. The bearings should then be fitted to the shaft. This is done by painting the journals with read lead and giving the shaft a few turns, which will make the high spots in the bearings bright and indicate where they need to be scraped. After the lower half of the bearing has been fitted to the shaft, the upper one is put in place and made to fit properly. When the bearings are fitted, the shaft is removed, the eccentric, governor driving device and other parts are mounted in their respective places, after which it is returned to its place and permanently secured.

It is well, at this point, to check the work and make sure that the shaft is level and perpendicular to the center line of the cylinder. This may be done by the use of the crankpin method. The shaft is turned to the position B, Fig. 4, and the distance C measured. It is then turned to D, and C′ measured. If C′ and C are equal, the shaft is perpendicular to the center line A. Care must be taken at all times that the line A is not deflected in any way. To test the level of the shaft, suspend a plumb above and in front of the shaft at the crank end, just touching the line A. Turn the shaft and measure as explained above.

When the crank shaft and crank are adjusted, remove line A and put the piston, piston rod and crosshead in place; then ascertain if the center line of the cylinder and center line of the piston coincide, by reference to Fig. 5. If the guides are properly lined, it will be seen that the piston rod will be parallel to the upper surfaces of the guides. This can be tested by measuring down to the piston rod from the lower edge of a straightedge laid across the upper surface of the guides, with the piston at the forward end of the stroke. If this distance is not the same at both ends, the crosshead shoes must be adjusted until these distances agree.

Testing the Crankpin

The next operation is to test the alignment of the crankpin. This is done by assembling the connecting rod upon the crankpin and taking the brasses up close with keys. Then put the crank on its dead center, as shown at A in Fig. 5, press the rod toward the inner guide B, to take up any lost motion in the crankpin and brasses, and measure the distance C. Turn the crank to the other dead center and measure C′. If the distances are the same, the center line of the crankpin is parallel to the center line of the shaft in the horizontal plane.

Place the crank on the upper half center at D, Fig. 5, take the measurement as before, and then turn the crank to D′ and check the corresponding measurement. If these agree, the center line of the crankpin is parallel to the center line of the shaft in the vertical plane. Where the differences in these measurements are slight, adjustment may be made by scraping the pin, but when much out of line, the pin must be machined.

Placing the Eccentric

The next operation is the alignment of the eccentric, which is done by fastening a line to the eccentric rod pin at the middle point of its length. Hold one leg of a square to the shaft with the end of the line held so as to touch the shaft and square. Then move the square along the shaft until the line touches the entire length of the other leg. Mark the place where the line touches the shaft and measure off on either side of this point a distance equal to 0.5 the width of the eccentric and shift the eccentric to its position between these marks.

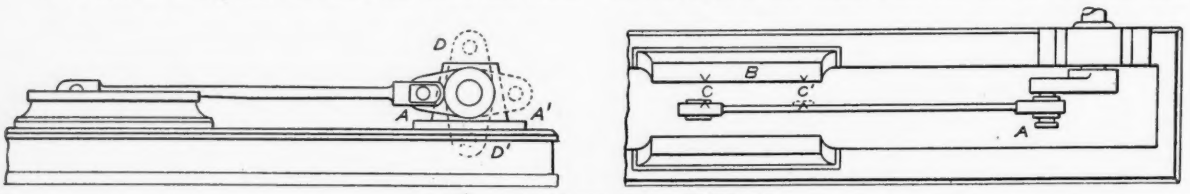


FIG. 5. LINING UP THE CROSSHEAD

After the engine has been lined, it is nearly always found that the crankpin and wristpin brasses do not fit and will need some adjustment. As soon as the crankpin has been trued it is possible to see if the crankpin brasses are at right angles to the center line of the connecting rod. To do this, put the crank on the center line and proceed precisely as in the crankpin adjustment. The same methods apply to the adjustment of the wristpin brasses.

The Wristpin

To line up the wristpin it is necessary to disconnect the connecting rod from the crankpin and key it up closely to the wristpin. Place the crank at its dead center and push the crosshead so that the crank end of the connecting rod rests on the crankpin. The line of center of the connecting rod should be the same distance from both collars of the crankpin. Repeat this

test with the crank at 90 deg. from its original position, and if the distances of the collars from the center line of the connecting rod are the same, the wristpin is in perfect alignment.

When all parts of the engine have been adjusted, the connecting rod is put in place. The brasses must be made to fit the crankpin and wristpin properly by scraping or draw filing, if necessary, until a snug and even fit is obtained. When the engine is finally started, plenty of oil should be used and the engine run at low speed until it is evident the bearings will not heat.

RETURN TRAPS FOR BOILER FEEDING

IN MANY plants, for the return of condensation from the heating system and other sources to the boilers, and for supplying the necessary feed water, 2 types of apparatus are used. The first is a pump, automatically controlled by the volume of condensation in the receiver; the second, the return steam trap. The high steam consumption of the steam pump, and the necessity for frequent repacking when used for hot water are disadvantages which can be overcome by the use of the trap.

Advantages of the Trap

Recently the trap has been developed to a marked degree so that it is both economical and reliable. It is simple in construction, easily adjusted and requires little attention, no supplies are needed except a small amount of packing. The steam used is only 15 to 20 lb. per horsepower hour.

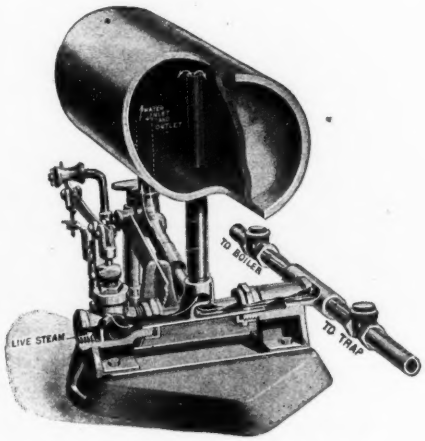


FIG. 1. SECTION OF RETURN TRAP

Construction

There are but few moving parts. The body of the trap is a tank of suitable shape, mounted on trunnions which are hollow and which leave the body free to turn. Through these trunnions, the water enters the trap, also the live steam for forcing the water out. Through these trunnions also, the water is forced out of the trap on its way to the boilers.

Mounted on pivots is a suitable weighted lever which returns the tank to its empty position after the water has been discharged. In this position, the air valve is opened, which allows the condensation to enter readily, and relieves the pressure after discharge is completed. A swinging check valve is placed in the supply pipe and another in the discharge pipe to prevent flow of water in the wrong direction.

Operation

Water from the piping system enters the receiver, from which it is forced upward to the trap by the steam pressure behind it. The tank or bowl, being pivoted on the trunnions, as before stated, is held in a horizontal position by a weighted lever.

When a sufficient volume of water has accumulated in the bowl or tank to overcome the effect of the weighted lever, the bowl or tank tilts downward, closing the air valve, and opening the steam valve,

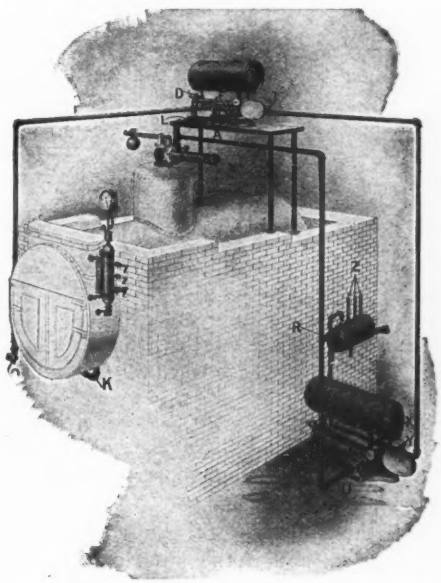


FIG. 2. MOREHEAD DOUBLE TRAP SYSTEM

Fig. 1, which admits steam direct from the boiler into the trap. This operation equalizes the pressures in the trap and in the boiler, allowing the water to flow into the boiler by gravity.

After the contents of the trap have been discharged, the weighted lever raises the receiving bowl or tank into the filling position. This action automatically closes the steam valve, and opens the air valve. The opening of the air valve relieves the tank from pressure during the filling of the tank.

Double Trap System

In the double trap system, each trap acts as above described, the second, or lower trap, discharging into the upper one. The second trap is placed on the floor

with the receiver above it, and the upper trap is situated at least 4 ft. above the water line in the boiler as in the single trap system, the piping being arranged as shown in Fig. 4.

Installation

The trap should be placed at least 4 ft. above the water line in the boiler, as in Fig. 5. A reservoir, or receiver, into which all the returns enter, should be connected to the trap, and is necessary to satisfactory operation. If the steam pressure at the receiver is insufficient to elevate the water to the trap, another trap must be connected between the receiver and the primary or feeding trap, to elevate the water to the upper trap, as in Fig. 2. To ascertain if 2 traps are necessary, allow 1 lb. steam pressure for every 2 ft. the water is to be elevated.

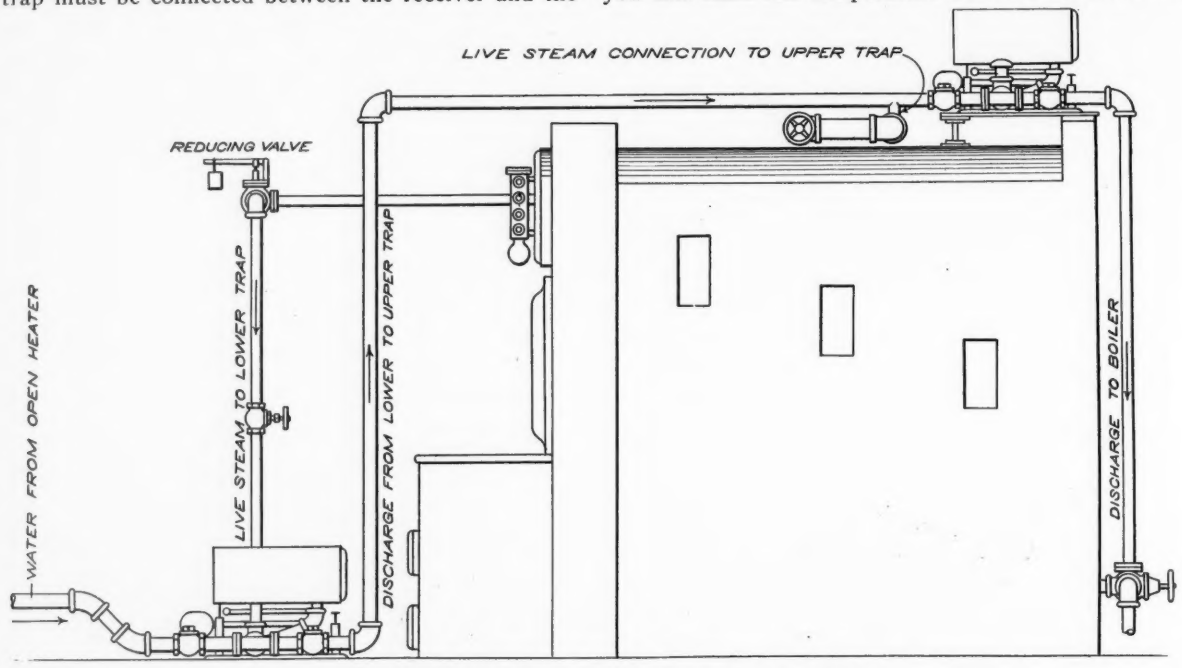

LIVE STEAM CONNECTION TO UPPER TRAP
REDUCING VALVE
WATER FROM OPEN HEATER
LIVE STEAM TO LOWER TRAP
DISCHARGE FROM LOWER TO UPPER TRAP
DISCHARGE TO BOILER

FIG. 3. ARRANGEMENT OF TRAPS IN THE STOTT MILLS

Piping the full size of the connections should always be used, and if the pipe line is long, or has several bends, the diameter of the pipe should be increased. A blowoff valve should always be connected to the bottom of the receiver for the removal of sediment, and to drain the receiver when necessary.

The volume of the receiver should be 5 times that of the tank or bowl of the trap.

When using a trap to feed a boiler with new water, the water must come to the trap with sufficient pressure to fill the tank. The trap cannot, of course, draw water up to itself.

A Noteworthy Example of a Steam Trap Feeding Boilers from an Open Heater

The conditions in this plant, which is in the Stott Mills, Detroit, Mich., are about as follows: There are 2 150-hp. and 1 250-hp. Babcock & Wilcox water-tube boilers; 1 500-hp. Allis-Chalmers tandem compound condensing engine and 1 100-hp. Monarch Corliss engine, the condensing engine being used in connection with a Wheeler surface condenser and a Cochrane open type feed-water heater.

The entire exhaust from the condensing engine goes, of course, to the condenser; the water from the condenser going to the open feed-water heater at about 110 deg. F. The exhaust from the Corliss engine is split, part of it going to the heating system and grain dryers in the mill, and part of it being used for heating the feed water in the heater. In this way you can raise the temperature of the feed water in the heater to from 206 to 208 deg. From the feed-water heater it is carried by a 4-in. main to a 3-in. Morehead return steam trap on the boiler room floor, which acts as a lift pump, delivering the water to another 3-in. trap placed above the boilers. This water leaves the heater at a temperature of from 206 to 208 deg. and when reaching the boilers (which are fed by the traps through the blow-offs) is raised to a temperature of from 255 to 262 deg., this rise in temperature being due to the action of the traps.

To show the economy of traps as compared to boiler feed pumps, if in the above installation we cut off entirely from the heater, the exhaust from the Corliss engine, and cut out the traps feeding the boilers, using the boiler feed pump and use only the exhaust from the pump to heat the feed-water in the heater, the temperature of the water in the feed-water heater will reach to from 208 to 211 deg. and will be delivered to the boilers by the pumps at that temperature.

If on the other hand we cut out the exhaust from the Corliss engine and shut off the boiler feed pump, and take the exhaust from both the traps back into

the feed-water heater, the temperature of the feed water will drop to from 165 to 168 degrees, this drop in the temperature of the feed water showing conclusively the difference in consumption of steam between the 2 traps and the boiler feed pump, as in this latter case both are working under practically the same conditions without the help of the exhaust from the Corliss engine, the traps consuming so much less steam in operation than the boiler feed pump, that the exhaust will not heat the feed water within 40 deg. of what the pumps will do, to say nothing of the fact that the traps put the water into the boiler at from 255 to 262 deg., which, of course, is much easier on the boiler than water going into it at from 208 to 212 deg.

The boilers here referred to are operating under about 140 lb. pressure.

While scientific tests have been made comparing the boiler feed pumps to the traps, it is evident from the fuel bills, that the traps as compared to the boiler feed pumps show a very much smaller consumption of coal; the engineer states that they give much less trouble, and cost much less money for repairs than the boiler feed pumps, and that he would under no conditions go back to boiler feed pumps in preference to the traps.

Feeding a Boiler Through a Closed Heater by the Bundy Trap

Return traps are used to feed direct to the boilers water of condensation from steam condensing apparatus of any description, from a reservoir of sufficient height to raise the water to the trap, which must be placed so that the water will flow into it by gravity; when full the receiving bowl settles down and pulls open the steam valve for the admission of live steam, which forces the contents out of the trap through the weighted check valve to the point of discharge.

When empty, the trap bowl returns to the filling position, closing the steam valve and permitting an inflow from the supply pipe. The trap will supply each hour a maximum quantity of water, according to size and capacity.

Water flows by gravity from the tank F, through the pipe E, the heater C, and the pipe D into the trap A, and through the pipe K into the boiler. A hand valve placed in the pipe K close to the boiler can be partially closed to reduce the flow of water into the boiler. The connection B will admit water from the city pressure, if such supply be available, or from a pump. The pipe H is the discharge from the vent or exhaust opening on the trap, which is closed while the trap is discharging and open while filling, in order to relieve the trap of air, and steam remaining in the bowl uncondensed, after the trap has discharged.

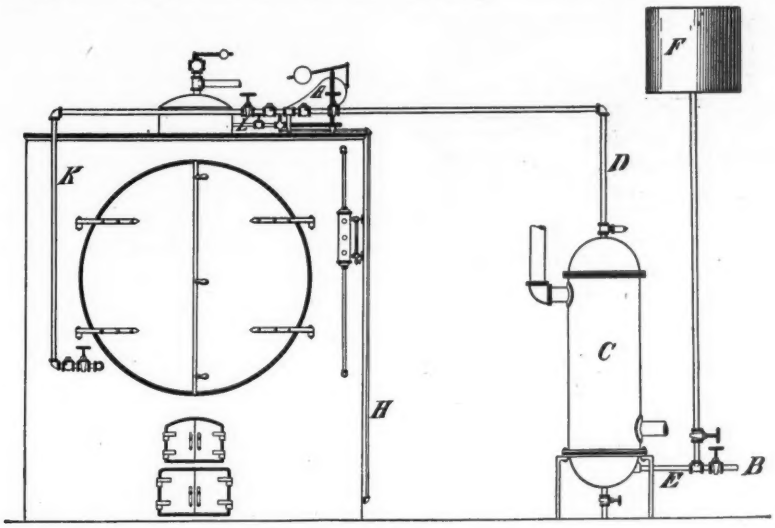


FIG. 4. SINGLE TRAP SYSTEM FOR BOILER FEEDING

THIS INTERESTING SUMMARY OF LIFE recently came into the office:

Did it ever occur to you that a man's life is full of crosses and temptations? He comes into this world without his consent and goes out against his will, and the trip between the two is exceedingly rocky.

When he is little the big girls kiss him and when he is grown the little girls kiss him. If he is poor he is a bad manager, if he is rich he is dishonest. If he needs credit he can't get it, if he is prosperous every one wants to do him a favor.

If he doesn't give to charity he is a stingy cuss; if he does it's for show. If he is actively religious he is a hypocrite, if he takes no interest in religion he is a hardened sinner.

If he gives affection he is a soft specimen, if he cares for no one he is cold-blooded. If he dies young there was a great future before him, if he lives to an old age he has missed his calling.

The road is rocky, but man loves to travel it.

THE CHICAGO ELECTRICAL SHOW

THE fourth Annual Exhibition of the Electrical Trades' Exhibition Co., was held at the Coliseum in Chicago from Jan. 16 to 30. All the booths in this large building were occupied by exhibitors of apparatus which requires the use of electricity. The entire annex was devoted to a display of the U. S. Naval Department, which consisted of relics, models and modern appliances for battle ships.

The Allis-Chalmers Co., of Milwaukee, Wis., occupied a large booth, which was decorated with ferns and flowers and in which were exhibited a 50 kw.,

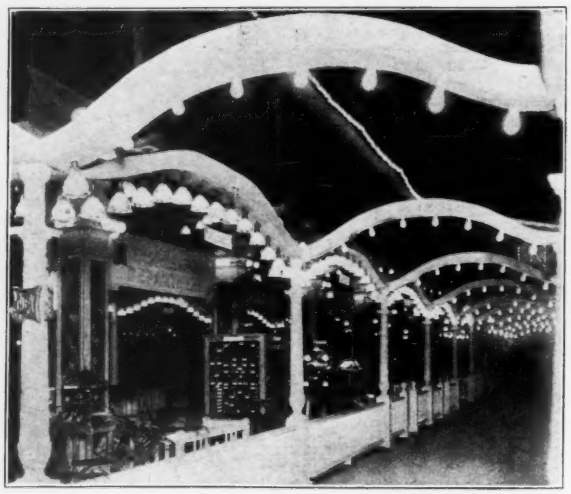


FIG. 1. THE EXHIBIT OF THE NATIONAL ELECTRIC LAMP ASSOCIATION

2-bearing induction motor-generator, 2 type K direct current motors, 2 induction motors, transformers ranging in capacity from 0.6 to 30 kw., a centrifugal pump and a portable air compressor. The company made a special exhibit of their transformers and considerable attention was attracted to the portable air compressor, which is a new design mounted on a hand truck. This company was also exhibiting a 60-kw., type A. H. belted alternating-current generator with a direct connected exciter, which was run by a 75-hp. pedestal type H, direct-current motor, this set being used to generate all the power which was consumed in the hall. The generator was run under severe conditions in that it had to stand from 50 to 75 per cent overload for short periods and its performance was exceptionally good. The exhibition was in charge of the publicity department, among those present being W. S. Heeger, assistant to the president; C. A. Tupper, head of the publicity department; W. A. Powell, chief engineer; B. F. Frankenfield, electrical engineer; S. R. Kurr, C. M. Howe and Irwin Dryer, Chicago office salesmen; C. M. Williamson, W. H. Yates and R. F. Bower.

The Crane Co. of Chicago had a full line of cast steel valves and fittings for superheated steam on exhibition, and also displayed its electrically operated gate valve, electrically controlled emergency and automatic stop valves and checks, pop safety and relief valves. The company also manufactures Klingerit packings, which are used for superheated steam fittings and called the attention of visitors to this product. The exhibition was in charage of J. A. Minwegen.

The Westinghouse Electric & Mfg. Co. of Pittsburg had on exhibition its mercury arc rectifier, which is used in charging storage batteries from an alternating-current circuit, its capacity ranging from 10 to 30 amperes. It was shown in operating condition connected to Westinghouse Machine Co.'s batteries, with wattmeter and other instruments connected in the circuit. A complete line of its new type S lighting transformers was also exhibited. Other apparatus manufactured by this company and shown in its booth consisted of prepayment wattmeters for residence and store use, metallic flaming arc lamps, which are of a new design, Cooper-Hewitt and Nernst lamps, alternating and direct-current carbon arc lamps, motors for use on direct and alternating-current circuits in sizes from ⅛ to 8 hp. and fans of various types. The multiple gap type lightning arresters for both pole and station service were also exhibited. J. C. McQuiston of Pittsburg, manager of the publishing department, was in charge of the exhibition and E. G. Reed was the demonstrator.

The Wagner Electric Mfg. Co. of St. Louis displayed switchboard instruments for both alternating and direct-current service. This company manufactures a line of commutator type single-phase motors and exhibited both the vertical and horizontal styles. Those who had the

The Western Electric Co. of Chicago laid particular emphasis in its exhibit upon its appliances for railway telephone service. Three types of this system are manufactured, known as the high speed Gill selector, unitype Gill one station selector and the Wray-Cummings synchronous clock selector. The company also exhibited the O'Connell lightning protector, a switchboard for intercommunication, railway composite and street railway telephones, testing sets, high pressure fire alarms, prepayment coin collectors and various other appliances, which are used in telephone practice.

The H. W. Johns-Manville Co. of New York displayed its Linolite system of lighting, having on exhibit both the metallic and carbon filament lamps, and showed their application to window displays. The company also exhibited its desk and table lamps and picture reflectors in different finishes. A complete line of Noark fuse material, special service and subway box material, a special line of high tension strain insulators, which are used in catenary construction, and the suspended type of porcelain insulators also were exhibited. The standard lines of pipe and boiler coverings manufactured by this company, also asbestos insulation and fire proof materials for buildings were shown in this booth. The following managers of electrical departments were in charge: Geo. A. Saylor, of the Milwaukee office; F. C. Frum-

veller, Detroit; H. M. Frantz, Chicago branch, and J. W. Perry, New York City.

The General Electric Co. made a special exhibit of its cooking utensils of all descriptions, including coffee percolators in various sizes, toasters, chafing dishes, corn poppers, electric baking ovens, electric fireplaces, electric cooking cabinets, luminous radiators, flatirons, etc.; tungsten, tantalum and carbon filament lamps were used in decorating the booth. The tungsten lamp was shown in sizes from 25 to 250 watts and an interesting photometer comparison was made between a 40 watt tungsten and a 32 candlepower carbon filament lamp. Two type I induction integrating wattmeters with one ampere winding were connected to show the relative amount of current consumption of the 2 lamps. Those in charge of the booth were E. L. Callahan, general manager heating device department; E. S. Keller, assistant, and Misses Potts and Schaffer, demonstrators.

The International Correspondence Schools of Scranton, Pa., had a distinctive and interesting exhibit, including the work of their students, full set of its reference library, and moving devices showing the scope of this school and advantages to be obtained by technical education. H. S. Hoover, superintendent of the Chicago district, and J. K. Kedan, assistant, had the exhibition in charge.

The Fort Wayne Electric Co. of Ft. Wayne, Ind., exhibited a 180-kw. alternating-current generator armature, together with fans, small power motors ranging from 1/100 to 1/4 hp. for use on either alternating or direct-current circuits, and wattmeters for both house and switchboard use. Particular attention was drawn to the compensarc, which is a new product of this company to be used as a controller of moving picture apparatus, and does away with rheostat losses and reduces the danger of fire. Those in charge of the booth were W. S. Goll, manager of Chicago sales office; A. L. Pond, L. A. Carr, Wm. S. Hine, H. Plumley, W. K. Eicher, salesmen, Chicago office, and W. S. Martin, from the Fort Wayne sales office.

The Chicago Pneumatic Tool Co., Chicago, Ill., exhibited a complete line of its electric drills for use in working wood and metal operated by either alternating and direct-current motors, an electrically driven hoist and grinders were also shown in operation at this booth. In charge of the booth was C. E. Coates.

The Robbins & Myers Co. of Springfield, Ohio, displayed its small power Standard motors for alternating and direct-current service, ranging in capacities from 1/30 to 15 hp., operating drills, lathes, etc. A vertical type motor was shown operating a centrifugal bilge pump, for which service it is particularly well adapted. The application of these motors was demonstrated by their use on desk and ceiling fans, card printing presses, exhaust fans, blowers, etc. The company exhibited a 3.5-kw. generator driven by direct connection to a 2-cycle 5-hp. 2-cylinder gasoline engine, this unit being frequently used for lighting small isolated buildings. The exhibit was in charge of H. A. Porter.

The Murphy Electricity Rectifier Co. of Rochester, N. Y., had in operation its rectifier, which is used for charging batteries from alternating-current circuits, electroplating, X-ray work, etc. This is an entirely new device, regulated by means of a rocker arm, which, coming in contact with certain contact points, permits the condenser to discharge at any point of the wave of the impressed voltage, thus doing away with vacuum tubes and chemicals. T. H. Murphy, the inventor of this apparatus, and Richard Murphy, director of the company, had charge of the booth.

The Northern Electric Mfg. Co. of Madison, Wis., demonstrated the operation of its electric rock drill, which was driven by a 1.5-hp. variable speed machine tool

FIG. 2. BOOTH OF THE WESTINGHOUSE EXHIBITORS

motor, type S. This motor has a speed range of from 500 to 2,000 r. p. m. and is field controlled. It is of a new design and commutation is exceptionally good at all speeds. The company also illustrated the use of a 3-hp. motor upon grinders, buffers, etc. This company's motor was also employed in operating an Atwood Vacuum Cleaner of the stationary type. The men exhibiting these products were Herbert Markle, manager of the Chicago office; Wm. Fox and A. E. Stevens, salesmen;

The National Electric Lamp Association, Engineering Department, Cleveland, Ohio, brought out in its display the development of the tungsten lamp from the ore to the finished product, and showed the use of the styles made at the present time. One case contained the minerals, tungsten ore, concentrates, and other substances, used in the manufacture of these lamps. The gem, tantalum and tungsten lamps, which are of a standard type, were shown in another case and the carbon, tantalum and tungsten lamps in miniature and low voltage sizes were also exhibited. Special uses of these lamps, such as for automobiles, train lighting and store window illumination were demonstrated. A comparison of the quality of the tungsten and carbon filament lamps was made by illuminating 2 store window displays placed side by side. The booth is outlined with tungsten lamps, bringing into effective use the different styles of reflectors.

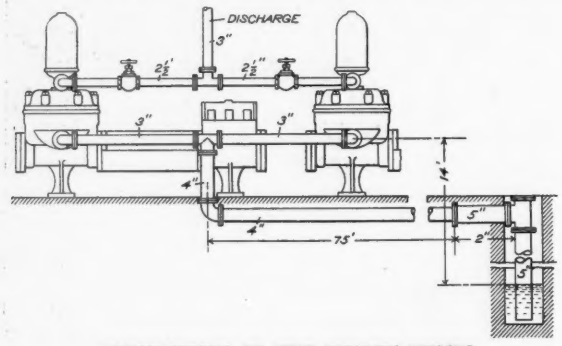
QUESTIONS AND ANSWERS

Our readers are invited to send in their troubles and problems; also to answer questions which are asked. All letters must have name and address of writer, which will not, however, be published. If answers are wanted by mail, send stamp for reply.

Pump Connections

F. K.—We have an artesian well that we pump water from. The water stands 14 ft. from the surface of the ground, while the 2 No. 6 Knowles pumps, connected as in the sketch, are 100 ft. from the well. Will the pumps work well connected together as shown?

A.—Probably the connection of the pumps as your sketch shows would work all right, if they do not



CONNECTIONS OF TWO DUPLEX PUMPS

run at a very high speed. A pump ought to lift water by suction 18 ft. without difficulty. It is quite likely that if the water stands 14 ft. below the surface when the pump is still, the water in the well level will fall when pumping comemnces. If this fall in level is not more than 4 or 5 ft. no doubt the installation will work satisfactorily as outlined.

Action of Injector, Setting Pump Valves, Blowing Off Boilers

P. A. McC.—A certain steam pump has a steam and water cylinder of 7 and 5 in. in diameter respectively, the steam pressure is 80 lb. What water pressure is necessary to balance the 2 pistons, or in other words, stall the pump?

2. Give 2 reasons why the water should remain in the boiler over night, when the boiler is to be washed out the next day.

3. How does an injector get its power to force water into a boiler?

4. Give 2 reasons why the water in the gage glass moves.

5. Why is lost motion given to the steam valves of a duplex pump?

A.—1. The ratio of the area of the steam piston to the area of the water piston is 1 to .51. Therefore, the pressure necessary to stall the pump, or balance the 2 pistons, is found by this proportion, .51 :80 :1 :x= 156.86, or in round numbers, 157 lb., neglecting friction.

2. If the water is allowed to remain in the boiler until a few minutes before washing out, the boiler is allowed to cool off slowly, and is not exposed to the heat of the hot walls with the possibility of injury if such practice is continued. Another reason for letting the water remain in the boiler, is that the sediment remains soft, and is readily removed, not having been baked on to the shell and tubes, as may occur when the boiler is emptied some time before washing it out.

3. The steam enters the combining tube in the injector with great velocity, and on meeting the cold water in the combining tube, the steam is condensed, the veleocity of the steam being imparted to the whole mass, cold water and condensed steam, which is sufficient to allow the water to enter the boiler.

4. The ebullition of the water in the boiler, when it is in service, will cause the water to move to a certain extent in the glass. Another cause, is that the feed water is not supplied at the same rate evaporation takes place. This means that the water in the boiler is rising and falling, and this condition will be indicated in the water glass if its connections are clear.

It has been assumed that you referred to ordinary working conditions and that the boiler is not foaming, which would cause the water to rise and fall rapidly in the glass.

5. Lost motion between the nuts on the valve stem and the steam valve in a duplex pump is necessary to enable the pump to run satisfactorily. When 1 piston is traveling, the other is at rest at a certain point in each stroke. It is the amount of lost motion in the steam valves that regulates the length of the stroke. The greater the lost motion the longer the stroke, and the less the lost motion the opposite effect.

The lost motion allows the piston of 1 side to travel a certain distance before the nuts on the valve stem engage the steam valve and reverse the valve, thereby reversing the direction of travel of the piston on the other side. This action takes place on each side as long as the pump is running.

The lost motion also enables the water valves to seat before the piston is reversed, therefore the slippage through the valves is small.

6. To set the valves on a duplex pump, place the rocker arms on each side plumb, or in the center of their travel. Then, place the steam valves centrally over the ports, and so adjust the lost motion that it is equally divided on each side of the valve. If the nut is inside the lugs on the valve, place the nut midway between the lugs. Move 1 of the valves to open 1 of the ports and replace the steam chest cover.

Steam Chest Cover Bolts; Evaporation.

J. H. K. 1. A steam chest cover is 42 by 24 in. How many steel studs 1¼ in. in diameter should be used to hold the cover, if the steam pressure is 160 lb. per sq. inch gage? Take the diameter at the bottom of the thread as 1.065 in. 2. A boiler evaporates 20,000 lb. of water an hour from a feed water temperature of 110 deg. into steam at 163 lb. gage pressure. If each pound of coal gives up 9500 B. t. u., how many tons of coal would be used in 7 days?

A. 1.—If the studs have a diameter of 1.065 in. at the bottom of the thread, they each will have an area of 1.065×1.065×0.7854=0.89 sq. in. A mild steel bolt for this purpose may be allowed a stress of 11,000 lb. per square inch of cross-sectional area, and if each bolt has an area of 0.89 sq. in., the stress on each bolt will be 11,000×0.89=9,790 pounds. A steam chest 24 by 42 in. has an area of 1008 sq. in., and if a pressure of 160 lb. is carried, it will support a total of 1008×160 =161,280 pounds. This divided by 9,790, the stress on each bolt, gives 16.5, or say 18 to make an even number.

One thing to be taken into consideration is whether this number of bolts will be near enough together to hold a gasket at this pressure. If not, judgment should be used in increasing the number.

A steam chest cover 42 by 24 in. in size is pretty large and we are assuming, of course, that it is plenty heavy to stand the pressure.

2.—The second question is solved by consulting a steam table, in which we find that steam at 163 lb. gage, or 178 lb. absolute pressure, has a total heat above 32 deg. of 1195.7 B. t. u. per pound. Your feed water is at a temperature of 110 degrees, so we must subtract as many B. t. u. from the total heat found as will raise water from 32 to 110 degrees. As 1 B. t. u. raises 1 pound of water 1 degree, it will be necessary to subtract 110—32=78 degrees from 1195.7, leaving 1117.7 B. t. u. which will be absorbed by each pound of steam in being raised to 163 pounds gage pressure. If the boiler evaporates 20,000 lb. an hour, it will take 20,000×1117.7=22,354,000 B. t. u. per hour and if each pound of coal gives up 9500 B. t. u. to the water, it will require 22,354,000÷9,500=235.3 lb. of coal an hour. Working 10 hours a day and 7 days in the week is 70 hours per week and 235.3×70=16,471 lb. of coal a week. This of course does not allow for raising steam, banking fires, etc.

Strength of Boiler

J.R.—Kindly figure the safe working pressure for a boiler constructed as follows: Tensile strength of the plate 52,000 lb. per sq. in.; thickness of the plate 7-16 in.; diameter 60 in. Rivets 15-16 in. diameter spaced 3 and 6 in. on centers in a triple riveted double butt strap joint. Shearing strength of rivets in single shear 42,000 lb. for 1 sq. in. cross section, and 78,000 lb. in double shear.

A.—Before the desired answer can be found it will be necessary to determine the strength of the joint as compared to the strength of the solid sheet before drilling rivet holes. Reducing the fractions, 7/16=0.4375; 15/16=0.9375; area=0.6902.

The plate section under consideration is 6 in. long and 0.4375 in. thick, with a tensile strength of 52,000 lb. per sq. in. So the strength of plate=6×0.4375 ×52,000=136,500 lb.

The strength of the sheet along the outer row of rivets is found thus: From the pitch of the rivets, subtract the diameter of the driven rivet, then multiply by plate thickness, and again by the tensile strength. The 15/16-in. rivet=1 in. in diameter when driven. So we have, 6—1=5×0.4375×52,000=113,-650 lb.

The rivets are figured as follows. There are 4 1-in. rivets in double shear and 1 1-in. rivet in single shear.

The shearing strength of a rivet of 1 sq. in. area is 78,000 lb. double shear and 42,000 lb. single shear. In our case the area is 0.7854 sq. in. and we have 78,000×0.7854×4+42,000×0.7854=279,031, shearing strength of the rivets.

The strength of the plate along the second row of rivets is found thus:

From the pitch, 6 in., subtract 2 times the diameter of a driven rivet, because there are 2 rivets in the pitch of 6 in. in the second row. Multiply this difference by the thickness of the plate, and by the tensile strength of the plate. To this product add the shearing strength of 1 rivet in single shear, 2×1 in.=2, 6—2=4 in.; 4×0.4375×52,000=91,000 lb. One rivet in single shear has a shearing strength of 0.7854 ×42,000=32,986.8 lb. which added to 91,000=123,986.8 lb. To find the percentage of strength, we divide the least strength as found above by the strength of solid plate, and have 136,500 lb. the strength of the solid plate before drilling and 113,650 lb. the strength of the plate along the outer row of rivets after drilling, as the values. Dividing 113,650 by 136,500 and multiplying the quotient by 100 will give the efficiency of the joint. In this case we have an efficiency of 83.26 per cent.

To find the safe working pressure, multiply the working strength by the plate thickness and the percentage of strength of the joint and divide by the radius of the boiler. With a factor of safety of 5 the working strength is 52,000÷5=10,400 lb.

Then we have, 10,400×0.4375=4550 and 4550× 0.8326÷30=127.9 lb. as the safe working pressure.

Duties of Switchboard Operator and Engineer

I would like to hear from engineers in different plants as to how the work should be divided in a power house that is large enough to employ outside the fireroom 1 engineer and 1 switchboard operator on a shift. For what part of the station should the engineer be responsible, and for what part the switchboard operator while on duty? W. G. B.

ELECTRICITY IN ALCOHOL MAKING

(*Continued from Page 106.*)

which is a copper tank having a steam coil lying on the bottom. This tank is 16 ft. in diameter by 12 ft. deep and has leading from the top a 20-in. pipe, which passes over into the bottom of what is known as the "column" and discharges under water, so that the vapor bubbles up through the water of the first section. It rises then through holes in a second plate and bubbles out of the nozzles in that plate through another layer of water, and so on, the passage being through 30 sections. In this way the temperature of the vapor is reduced to that just sufficient to evaporate pure alcohol, and the pure alcohol bubbling through the third compartment in the same way, and from that to the fourth compartment, out of which it goes through a coil and passes off to the condenser. A blowoff is provided in the bottom section for removing the residue.

Small beer is fed in at the top and in the upper section it is heated, but does not evaporate. It is then let down from the top to the third section, where it is partly evaporated, and then dropped from the third section to the second section, where still further evaporation takes place, and finally from the third to the fourth section, where the steam is allowed to blow through it until it is "worked out," when it is blown off to the slop tub, and the change from the second compartment let down into the first, from the third to the

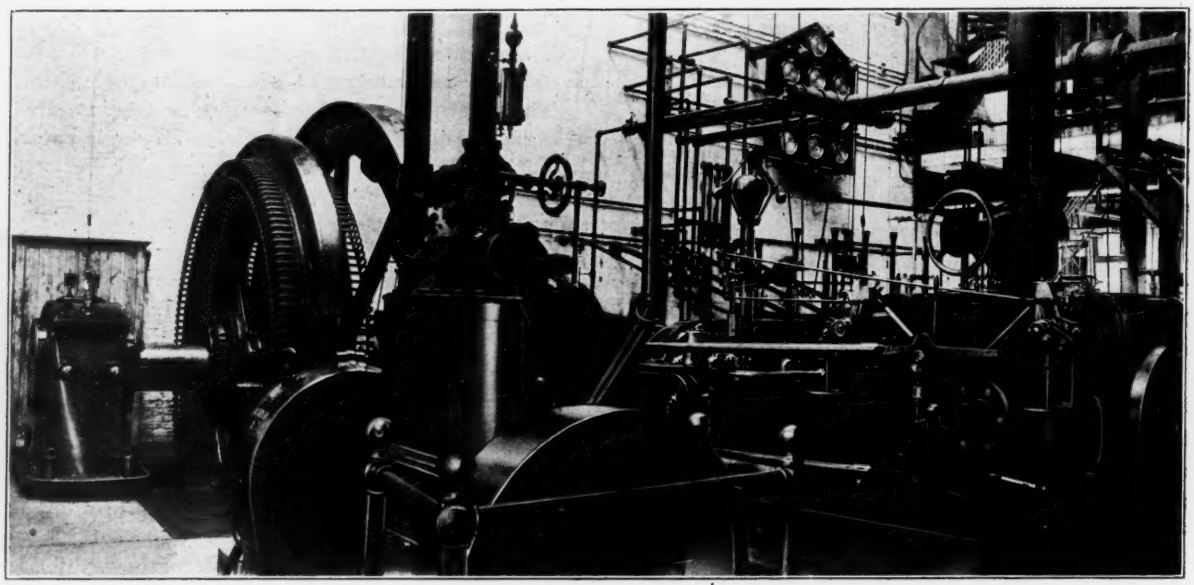


FIG. 6. 350-KW. GENERATING UNIT

liquid on the top plate, passes out of the top of the column and over to a series of copper return bends, called the goose, which are submerged in water.

Passing through these return bends the vapor is cooled, then goes to a condenser or cooler, which is simply a surface condenser arrangement, and from there runs to the tail box, where it is watched for temperature and for purity. Any condensation which may occur in the bends of the goose coil is drawn off by a drip pipe and returned to the distilling column.

Whisky Distillation

When whisky is to be produced, a single distillation suffices. What is known as a "chamber whisky still" being used. The process is intermittent and is somewhat the same in character as if the 2 stages of alcohol distillation were combined. Steam passes in at the bottom of the still and bubbles through a layer of the liquid located in one compartment. From this compartment, which is 7 ft. high, the vapor rises through a pipe to the second compartment and bubbles through the layer of liquid there. It then passes to the second, and from the top to the third. After the whisky has been distilled and condensed it is taken to the barreling warehouse and measured into oak barrels, which are charred on the inside. In these it is allowed to stand in the bonded warehouse for 4 yr., when it becomes, according to the government requirement, suitable for sale as whisky.

The manufacture of gin is somewhat the same as that of the second distillation for alcohol, except that the vapor is passed over a mash of juniper berries and the liquor is distilled twice, and sometimes 3 and 4 times, to give it the required purity and standard. The stills are big copper affairs and have at the top a still head, which is the shape of the dome on a Turkish mosque, 5 ft. in diameter, and is a remarkable piece of handiwork, as it is beaten up from a single sheet of copper and has no joint of any kind in it.

The process of barreling is simply one of drawing from large tanks into barrels and the proving up by the government inspectors and stamping the barrels. The only machinery required in this process is a device

for driving up the hoops on the barrels to be sure that they are tight, and a machine for putting in the bungs.

The Steam Plant

It is evident that so much of distillation calls for an immense amount of steam, and in the power house the unusual condition is found that the live steam pipe is 18 in. in diameter, while the exhaust steam pipe is only 12 in. The steam from the engines is carried through the beer heater and is found insufficient for the needs of that apparatus, so that live steam has to be used all the time. There is, therefore, no great object in economy of steam in this direction, but for stills, the cookers and other requirements pure live steam must be used anyway, and it has been found that the installation of the electric motor drive which is now in use has resulted in a very material saving in the coal bill for the plant over the shaft and belt drive used in the old plant, while the capacity of the 2 plants is practically the same, the output being somewhat greater at the present time than it was before the burning of the old plant. The electric motor drive is used throughout, the only place where steam is used being for the driving of pumps and for a couple of old engines in the feed house, which run but seldom.

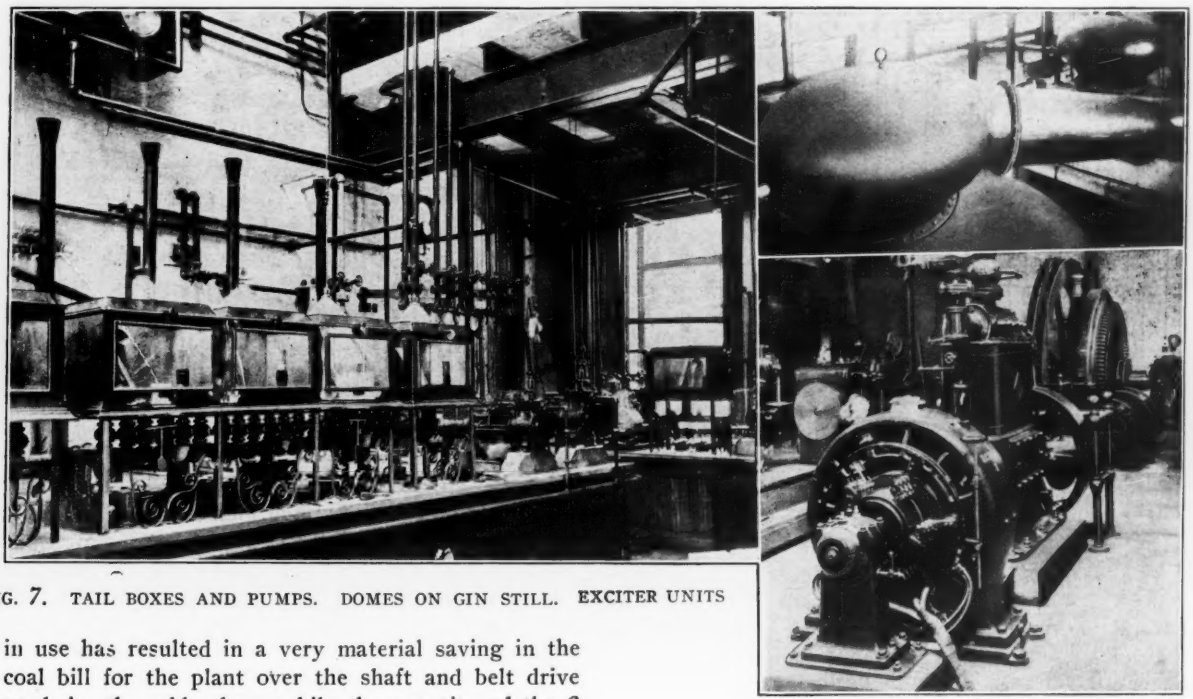


FIG. 7. TAIL BOXES AND PUMPS. DOMES ON GIN STILL. EXCITER UNITS

Boiler Room

The boiler plant which provides steam for these needs consists of 9 Wickes vertical water-tube boilers, fed by Brightman automatic furnaces. They are 300 hp. capacity each, carry steam at 95 lb. pressure, which may be reduced to 85 lb. at the engines by an emergency load. The furnaces have inclined grates, which by means of moving bars automatically feed the coal backward and downward, a screw gear mechanism being used to drive an eccentric motion, and this screw gear being driven from a shaft which runs along the front of the boilers, the shaft in turn being driven by a small steam engine, which has an electric motor in reserve for emergency.

The boilers are fitted with Pittsburg Gauge & Supply Co.'s water columns and are arranged with platform for the water tender at the water glass level. Boilers are set in 2 batteries of 8 each and a single boiler which has its own stack. Ashes are dropped from the furnaces into an ash tunnel and are taken out by hand to the railroad tracks, where they are delivered to the railroad for filling.

Steam from the boilers is fed ino parallel mains, 1 18-in. for regular service, and 1 6-in. for emergency. Water is fed to the boilers by means of 2 simple duplex pumps cross connected, so that either one may be used for the entire boiler equipment. These draw from wells and feed into a manifold header, from which the feed pipes lead to the individual boilers. In the boiler room are installed 2 Wickes open feed-water heaters, which take part of the steam from the engines for heating the feed water.

Pumping Installation

The water supply for the plant is taken in part from the river and in part from 2 driven wells. The river water is used only for cooling the condensers in the distilling plant and for washing, as the steam from the boilers is largely used in cookers and heaters and must be pure. To supply the water needed 3 power-driven pumps are installed in the pump house and are belted to induction motors located on a platform above, so that the belt runs at an angle of 45 degrees. One of these pumps draws water from the river and forces it

against a discharge head of 45 lb., the suction head being 6 lb., to a tower, from which it is supplied to the plant. The other 2 pumps take water from wells and force it into tanks located between the boiler house and the pump house.

All 3 of these pumps are Worthington double-acting duplex belted type, 15 by 15 in., the pulleys being 90 in. in diameter by 17 in. wide, with a gear reduction of 61, and being driven by 120-hp. induction motors having pulleys 20 in. by 11 in. running at 580 revolutions per minute. The belt used is a 10-in. 6-ply rubber. These are the only pumps in the plant driven by motors.

For putting vacuum on the cookers when required, for pumping the mash from the mash tank to the fermenting vats, and for pumping the small beer from the tank to the stills, a battery of pumps is installed just at the end of the cookers. The mash pumps are 3 in number, while a single pump serves for forming the vacuum and is piped so that it can be connected to any one of the 3 cookers.

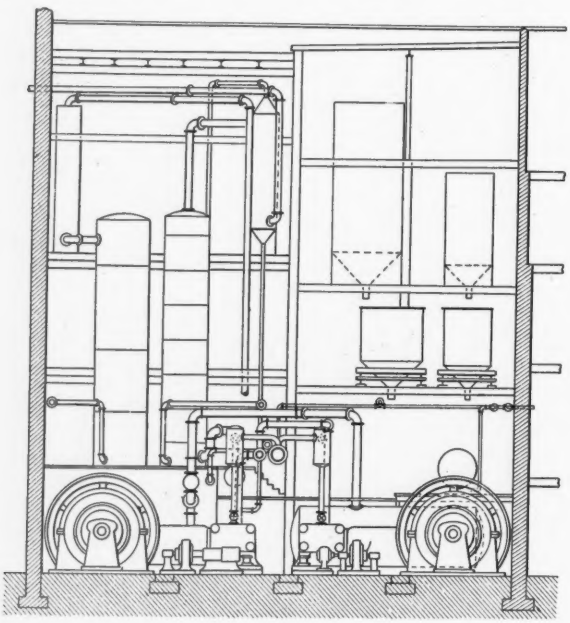


FIG. 8. ELEVATION OF MILL BUILDING AND ENGINE ROOM

The others are all direct-acting duplex steam-driven pumps, mostly used for the handling of the mash, the small beer, the thin slop and the alcohol product. Besides those shown on the drawings of the engine and cooker room, there are pumps installed in the alcohol tower, in the feed house and in the rectifying house, at points as needed. Most of these are of the Worthington make, although a number are found made by Dean Brothers, of Indianapolis, and some by the Gardner Governor Co., Quincy, Ill.

Motors

As already mentioned in the description, conveying and elevating machinery is driven by electrical motors throughout the plant. All motors used are of either 10, 30 or 50 hp., Westinghouse C. C. L. 3-phase induction, and all are planned to run at 900 revolutions a minute, or an actual speed of about 850. This makes it possible in case of burning out of any one motor to substitute another motor, which may not necessarily be of the same horsepower, but will run at the same speed. One spare motor of each size is kept on hand and also a complete set of windings for each size of motor. This makes it possible at short notice to put a motor in place of any one which may be injured in the plant and to have the new winding, or part of the winding, as may be necessary, quickly put onto the damaged machine, so that it is practically impossible to shut down the plant for any length of time by any injury to 1, 2 or 3 motors.

The total motor load connected is 740 hp., and there are besides about 1,350 16-candlepower incandescent lamps. The readings show that the average load on the plant through the winter season is 60 per cent of the connected capacity of motors and lights.

Generating Units

To furnish current for these motors 2 generating units are installed, 1 of these having a nominal capacity of 250 kw. and, the other 350 kw. Both machines are of the rotary field type and furnish 3-phase current at 220 volts, no transformers being used, as the transmission distances about the plant are not long. The larger machine is driven by a 26 by 42-in. Murray Corliss engine, which is rated to give 420 hp. with an initial pressure of 85 lb. and back pressure of 10 lb. at 100 r. p. m. It has all the standard features of the Murray direct-connected rolling mill type, heavy frame, designed so that the metal goes in the direct line of the stress, large bearings, large double steam ports and sensitive governor with safety stop attachment and arranged so that the speed of the engine can be changed while the engine is running. The rotating part of the generator is carried directly on the armature shaft, next the flywheel, which weighs 31,000 lb. The heaviest piece of the generator itself is the rotor, which weighs 13,000 lb. and is 10 ft. in diameter. The steam supply pipe to this engine is 10 in. in diameter, the exhaust 12 in., and steam comes in through a 10-in. angle receiver type Swartwout separator, made by the Ohio Blower Co.

The engines are fitted with wrought-iron shafts, the dimensions for the 420 hp. being 15.5 in. diameter in the armature, journals 30 by 30 in., crosshead pin 6 by 7 in., crosshead shoe 12 by 20 in., and crankpin 7 by 7 in. The large generator is guaranteed to give an efficiency of 93 per cent at full load, 92 per cent at ¾ load, and 89 per cent at half load, and takes exciting current of 120 amperes at 100 volts. The armature is bar wound with mica insulation, the windings being placed in a slotted drum. The revolving field is strap wound, the straps being placed on edge. These generators are both Westinghouse engine driven type.

The smaller generator is a 250-kw., driven by a 22 by 42-in. Murray Corliss engine rated at 280 hp. This runs 106 r. p. m., furnishes 665 amperes per phase at 220 volts, has 72 poles, and has a guaranteed efficiency of 92¼ per cent at full load, 91¼ at ¾ load, and 88¼ at ½ load. The field exciting current is 100 amperes at 100 volts, and the heaviest piece weighs 14,000 lb., this being the frame, which is shipped in one piece.

Owing to the smaller weight of the rotating part and the less number of poles in this machine, it requires a heavier flywheel than the big one, the weight being 34,000 lb. The engine which drives it is of the same type as for the larger unit; it has a cylinder 22 by 42 in. with shaft 14.5 in. diameter, steam pipe 8 in. diameter, and an exhaust pipe 10 in. The flywheel is 15 ft. diameter; 2 eccentrics are provided, 1 for steam and 1 for exhaust valves, the valves being double ported.

Exciters

Excitation for the generators is supplied either by a steam-driven exciter unit, which consists of a Westinghouse Junior 10 by 9 engine, rated at 50 hp., driving a 30-kw. 125-volt Westinghouse direct-current generator, or by a motor-generator exciter set, which consists of a 50-hp. Westinghouse 3-phase motor running at 200 volts and 900 r. p. m. and driving a Crocker-Wheeler 30-kw. generator at 125 volts. The steam-driven exicter unit can also be used for operating the incandescent lights about the plant at times when the main generators are shut down, the lighting panel of the switchboard being arranged to throw the lights on either direct current or alternating current, as may be desired.

Switchboard Connections

The way in which the electrical system is connected up is indicated in the connection diagram, Fig. 9. For controlling the circuits the switchboard is divided into 6 panels, 1 being for the lighting system, 1 for the exciters, 2 for the generators and 2 for the power feeders. The board has at the end swinging voltmeters for the alternating and direct-current systems, and above the board are mounted a synchroscope and station wattmeters, showing the power on the lighting and motor circuits.

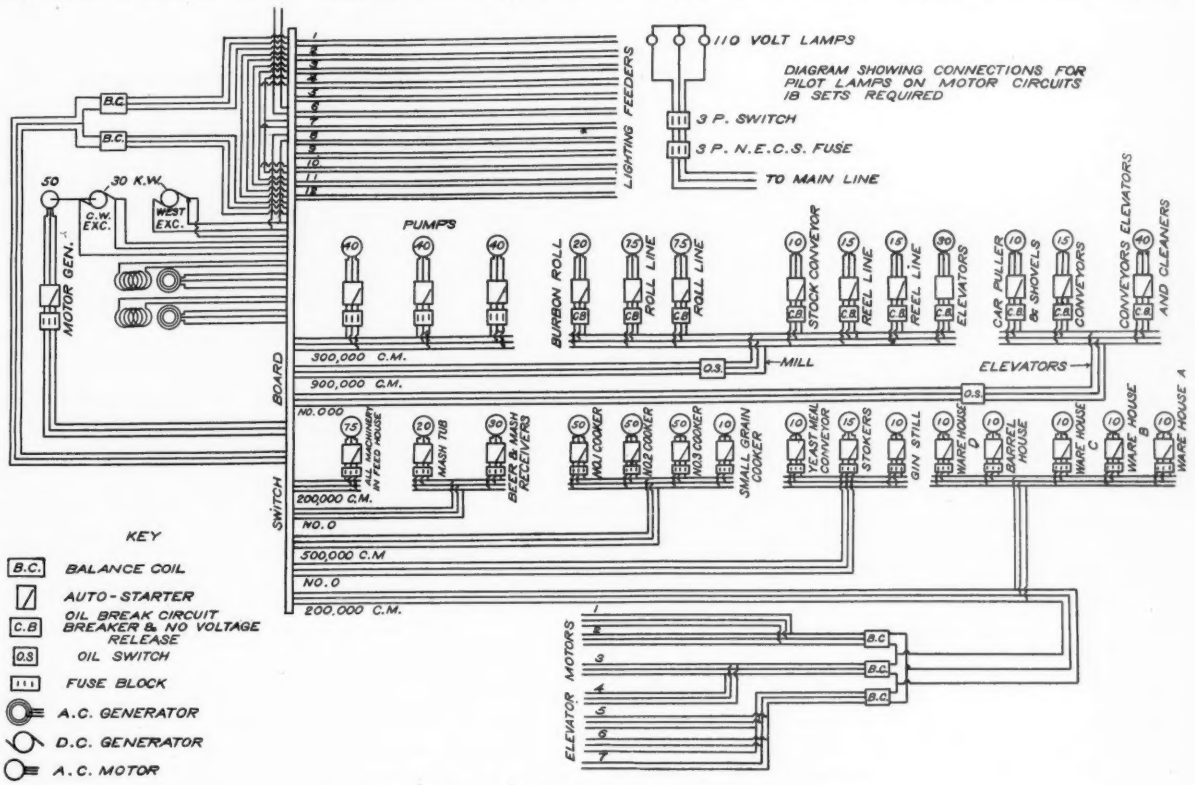


FIG. 9. DIAGRAM OF ELECTRICAL CONNECTIONS

LIGHTING FEEDERS: 1, CLUSTER LIGHTS FOR YARD; 2, OFFICE; 3, TOWER; 4, ENGINE ROOM; 5, MEAL ROOMS; 6, ELEVATOR; 7, MILL; 8, FEED HOUSE; 9, BOILER HOUSE; 10, GIN HOUSE; 11, LEACH HOUSE; 12, YEAST AND PUMP HOUSES.
ELEVATOR MOTOR FEEDERS: 1, FERMENTING HOUSE; 2, BARREL HOUSE; 3, 4, 5, 6, WAREHOUSES; 7, FAN HOUSE.
SIZES OF MOTOR LEADS: 10 HP. 25 AMP. NO. 8 WIRE; 15 HP. 38 AMP. NO. 6 WIRE; 20 HP. 50 AMP. NO. 4 WIRE; 30 HP. 75 AMP. NO. 2 WIRE; 40 HP. 100 AMP. NO. 0 WIRE; 50 HP. SPECIAL, 300,000 C. M.; 75 HP. 188 AMP. 200,000 C. M.

The usual provision of Westinghouse instruments is made as needed for controlling the system, and a Tirrell voltage regulator for steadying the fluctuations. The board was made and erected by Kohler Brothers, of Chicago. Wiring from the generators to the switchboard is carried in underground conduits made of tile ducts, and the leads being of Roebling rubber covered

cable having cambric insulation. The feeder leads to the pump house and cookers are of the same style of cable, made up triplex with 3 wires in 1 shell, and other cables about the plant are the rubber-covered Underwriters' wire. At no place in the plant are there any exposed terminals or contacts except in the station room. Fuses are protected by iron boxes, and at all points are of the enclosed type, so that no sparks can be formed.

Mill and elevator circuits are protected by overload

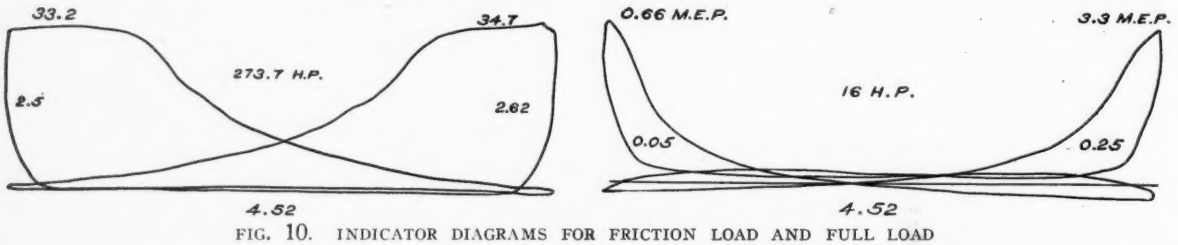


FIG. 10. INDICATOR DIAGRAMS FOR FRICTION LOAD AND FULL LOAD

circuit breakers having underload release coils, and the switches are of the oil break type.

The provision of safeguards against fire throughout the plant is complete, and it does not seem possible that any combination of circumstances could by any possibility cause the starting of a fire in the new buildings. An indication of what the plant can do in emergency is given by the fact that at one time when there was some derangement of the smaller generating units, the larger, which is rated to carry 920 amperes per phase, carried 1,300 for a period of 8 hours, and although it naturally became somewhat heated, there was no injury done to the machinery.

The piping has been carefully laid out to give the most direct runs possible and has been so arranged that all valves and pipes are readily accessible. Extra heavy fittings have been used at all point and flange joints, so that a joint can be broken anywhere in the lines when necessary. The plant is one which shows in its make-up the intimate knowledge of both the special requirements of the distilling business and the requirements for good economy in a power plant which were brought to bear on the problem by the general manager, Mr. P. Casey, and the consulting engineer who drew the plans and supervised the installation, Clay Belsley, of Peoria. The wisdom of the careful guarding against fire is shown by the reduction in insurance rates, which alone will pay for the extra cost over wood construction within a short time, and by the reduction in fuel consumption, which will also show a handsome profit on the investment.

We are indebted to both Messrs. Casey and Belsley for courtesies in furnishing the information for this article and for photographs and blue prints of the plant.

LOOK THE WORLD square in the eye. If it's friendly, smile and hold out your hand. If it tries to trip you, duck, dodge and biff it in the neck.—Graphite.

PILLEY COMBINATION FLUE BRUSH AND SCRAPER.

The accompanying cut illustrates a new combination flue brush and scraper manufactured by the Pilley Packing & Flue Brush Mfg. Co., 614 S. Third St., St. Louis, Mo. The scraper cuts the scale off the tube, and it is then pushed out of the tube by means of the steel wire brush shown, the tube being cleaned in one operation. The scrapers are made of malleable iron, and carried on 4 steel arms, which are fastened in the center. They are expanded or contracted by turning the rod to the right or left, thereby moving the slide up or down on the threaded rod in the center.

The brush is made of fine round tempered steel wire, the wires passing entirely through the holes in the center and being fastened on the inside, making it impossible for them to come out or lay over. The whole tool is constructed of the best material, and designed for hard and rough usage. It will save time and labor, thus appealing to both proprietor and engineer.

THE PILLEY SCRAPER AND FLUE BRUSH

A NEW PIPE JOINT CEMENT

Red and white lead and the ordinary pipe joint cements on the market are sold ready mixed with either water or oil, and as a result the customer in buying these cements pays a high price per pound for the water or oil, as well as for the cement proper.

To obviate this disadvantage, The H. W. Johns Manville Co., of New York, has recently placed on the market what is known as H-O Pipe Joint Cement, which is put up in powder form and can be kept in stock indefinitely, as it does not dry out or deteriorate. In using it, the cement is mixed with either water or linseed oil, making it ready for use.

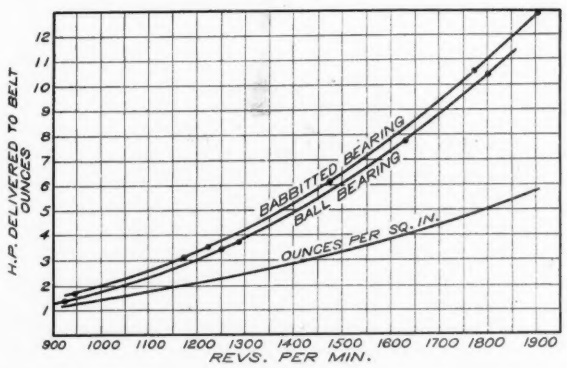
The chemical properties of H-O Cement are such that it expands after the joint is made up, thereby making a perfectly tight joint. It does not harden as does red or white lead and the joint made with it can be easily broken at any time without danger of breaking the fittings.

The manufacturers claim that 1 lb. of H-O Ce-

ment, mixed with water, is equal to 4 lb. of the ordinary ready mixed cements, thus proving the economy of using this form. H-O Cement has the additional advantage that it is not poisonous like lead cements and does not taint water.

POWER REQUIRED BY AN EXHAUST FAN

Report of a series of tests of an exhaust fan, conducted by Prof. Charles H. Chase, at the engineering laboratories of Tufts College, presents some interesting facts. The object of the test was to show the difference, if any, between the power required to drive a fan equipped with the ordinary form of babbitted bearings and one provided with ball bearings. For



RELATION OF SPEED TO DRIVING POWER AND PRESSURE PRODUCED IN COMPARATIVE TEST OF BABBITTED AND BALL BEARING FANS

the purpose, there was taken from the regular stock of the Massachusetts Fan Co., one of its standard ball-bearing exhausters. This was provided with an interchangeable set of babbitted bearings, so that tests could be conducted with the same wheel and casing, the only difference being in the bearings.

The casing was 35 in. high, by 13.25 in. wide, the wheel being 24 in. diameter, of the "long shaving" planing mill type without side platen. The fan was run at various speeds ranging from about 900 up to 1900 r. p. m. Various areas of discharge were provided by means of tapering nozzles attached to the outlet. These were graded from the smallest, having about ¾ the capacity area of the fan, up to the largest, with double the capacity area. According to the area of outlet the pressures at the highest speed ranged from about 6 oz. down to about 3 oz. per square inch. The power ranged from about 1.5 hp. with the smallest outlet at the lowest speed, up to 13 at the highest speed observed, about 1680 revolutions, with the largest outlet.

Throughout this range the ball-bearing fan showed decided superiority, the average saving in power being 8.3 per cent as compared with the babbitted bearing type; at low speed it ran up to about 11 per cent.

The dollars and cents value of such increased efficiency is evident. If, with the ball bearings, 8.3 per cent of 13 hp., for instance, on a 35-in. fan can be saved, it amounts to a little over 1 hp. If this cost $50 a year the saving would be equal to 25 per cent, an excessive figure to cover interest, taxes, insurance and depreciation, on $200 extra, which might be paid for a ball-bearing fan as compared with one with babbitted bearings, and still come out even on fixed charges. But $200 is more than the list price of such a fan, hence there cannot fail to be a material saving resulting from the use of the ball-bearing type. Under ordinary conditions it would pay for itself inside of a couple of years.

GREASE VERSUS OIL

BY JOSEPH B. BAKER

Lubrication is an all important question to every owner and operator of machinery. At the present time lubrication of machinery is effected to a great extent by the use of oil, owing to a long-established cutom and to certain conditions in the oil business. The point that it is desired to make here is one that is so simple and obvious that it is in danger of being lost sight of altogether: Lubrication is a greasing proposition.

In the use of oil as a lubricant, the fluidity of the oil is depended on to carry its greasiness to all parts of the bearings. It is the greasiness of the oil that does the work; many oils that do not possess that quality are useless as lubricants, and the value of the oil as a lubricant is, other things being equal, in proportion to its possession of that quality. Many devices and systems have been invented for getting the oil—a liquid lubricant, or liquid grease, as it may be termed—into the bearings. These devices range in ingenuity from a single oil hole to an elaborate force feed system; all of them have for their object the greasing of the wheels of industry through the medium of oil. Oil lubrication should have constant attention if the owner or operator of the machinery wishes to reduce friction to a minimum; the oil should be fed in uniform, adequate quantities, just sufficient oil to make the friction as low as possible. The most successful methods of oil lubrication are by oil baths and by automatic feeding, by means of either of which the bearings are kept constantly flooded. The oil must also be adapted to the particular bearings on which it is used. Some parts of the machines can be operated with almost any oil, whereas other parts can hardly be worked at all without being supplied with a particular kind of oil. The least possible friction is obtained when the oil has sufficient body to keep the journal and bearing apart. We then have true fluid friction, merely; but if the oil is weak it soon "wears out" and we have a close approach to solid friction, with vastly increased power required to overcome it.

Some years ago these disadvantages were realized to a certain extent as being due to the use of oil as a lubricant, and supply houses began to look around for something to take the place of oil. They found that a grease could be obtained by taking a product of petro-

leum; and with the addition of resin, resinous oil, tallow, graphite, talc and beeswax to this substance, they could produce, in part, the much-desired results. This line of compounds was placed on the market at a small cost to the manufacturer, and at a large profit, the consumer being left to decide the merits of the products. The oil user took this method of lubrication gladly, imagining that the vexed problem of lubrication was solved at last, but he soon found the bearings of his machines heating more than ever, the journals and boxes black and sticky, and the wear almost as great as before. To cap the climax, he found that the oleaginous substance in his cups and boxes rapidly melted, following the bad precedent of oil, and that after awhile there was left only the filling, or "body" of the so-called lubricant.

While the extensive use of poor, adulterated grease has hitherto given the whole subject of grease lubrication somewhat of a bad name, the fact remains that good grease at a reasonable price is an ideal lubricant, owing to its freedom from objectionable properties inherent in the liquid lubricant, oil.

Such a grease has been developed, it is claimed, by the Keystone Lubricating Co., of Philadelphia, which took up the subject of grease lubrication some years ago. At that time this company felt that the highest criterion of a high-grade lubricating oil—a criterion which oil can approach only with the aid of expensive "lubricating devices" is to do the work of a perfect grease; and it claims to have realized this criterion, after patient research, in a pure, natural product composed of the best materials and maintaining in the bearing a slippery non-corrosive film having the minimum coefficient of friction, at the minimum cost. This product, known as Keystone Grease, is claimed to be cheaper in first cost and more durable than any other oil or grease now on the market, to be wholly free from objectionable body or corrosive substances, and to require less attention and give more all around satisfaction. Its freedom from wasteful melting away means practically, it is stated, that a single pound will outlast 4 gal. of oil employed for the same work, without leaving any gum or sediment behind.

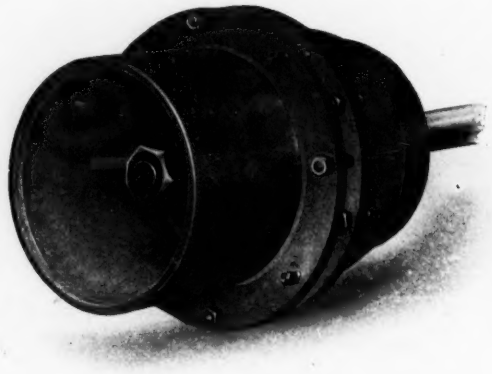
Chemical analyses of this lubricant have been made by experts showing that no resin, resinous oils, mineral or fatty acids, matter such as clay, grit, graphite or volatile matter, such as naphtha or benzine or any other substance detrimental to machinery enters into its composition. Mechanical tests in comparison with different high-grade oils, made by competent authorities, are stated to show for this product the lowest coefficient of friction and lowest rise of temperature in the bearing. The tests also showed that it is unaffected by extremes of temperature, such as prolonged boiling in water or exposure to cold, and that it does not become rancid or suffer change under any climatic or atmospheric conditions.

ONE TON OF ANTHRACITE COAL is about 42 cu. ft.

THE SCHILLER PACKED PLUNGER STUFFINGBOX.

For elevator pumps and other high-pressure machinery the plunger and ring pattern of pump is in favor, but with this type it is difficult to prevent slip of the water between the plunger and rings. Plungers are made of cast iron and the ring is bushed with brass and, unless provision is made for taking up the natural wear, the slip of water between the plunger and ring is considerable after a short period of operation. As the cost of a new pair of plungers and rings is considerable, the slip is likely to be allowed to go on for a long time.

With the arrangement furnished by Schiller & Co., of Philadelphia, the plunger is kept perfectly tight



THE SCHILLER PLUNGER AND STUFFING BOX

with slight attention from the engineer, who occasionally screws up on the gland. This gives a device which need not be repacked oftener than once a year and when repacked the cost is slight. Either metallic or fibrous packing can be used, according to the preference of the engineer.

The stuffingbox and gland occupy no more space in the pump chamber that does the plunger and bushing ring, so that access to the suction valves is just as ready as by the older system. By this method of packing, the plungers are kept in line with the steam end of the pump, avoiding any tendency to break or wear the piston rods. By the use of this device the manufacturers state that they have been able to show a saving of never less than 10 per cent of the steam used in a pump to accomplish a given amount of work and that in many cases the saving has exceeded 30 per cent.

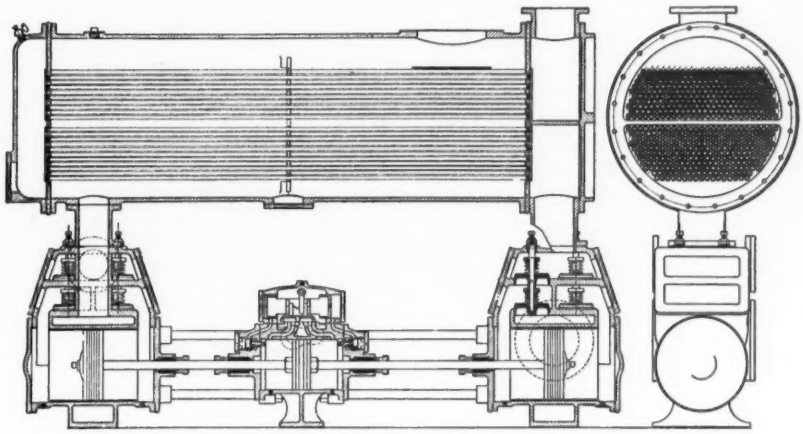
Plungers are fitted to the piston rods already in the pumps and the stuffingbox joint is fitted absolutely tight to the pump diaphragm. That part of the plungers which works through the stuffingbox is of brass and the stuffingbox is brass bushed, so that even without the packing there is as good a joint as by the plunger and ring method, and as wear takes place the packing takes care of this to prevent friction. Four set screws are provided in the gland so that when

it is set up to the right position it can be rigidly locked in place. The arrangement of the piston and stuffing-box is shown in the illustration herewith.

CAMERON SURFACE CONDENSER . WITH COMBINED AIR AND CIRCULATING PUMPS

This apparatus is especially useful for locations where the water supply for condensation is salt or unfit for boiler feed, and where it is desired to save the condensed steam for that purpose. It will readily maintain a vacuum of 26 in. referred to a 30 in. barometer when supplied with sufficient cooling water.

The condenser is mounted on top of a direct-acting combined air and circulating pump, the 3 cylinders of which are in a straight line; the steam cylinder in the center and the air and water cylinders at either end. By this arrangement a very smooth and steady running pump is ensured, as the regulating action of the water pump equalizes the irregular load on the air pump.



CAMERON SURFACE CONDENSER WITH AIR AND CIRCULATING PUMPS

The water chamber of the condenser rests directly on top of the water cylinder and the circulating water passes upward from the water cylinder and through the lower bank of tubes, returning through the upper bank and out at the highest point of the water chamber, the arrangement being such that no air can lodge in the condenser tubes and impair their efficiency. Exhaust steam entering the top of the condenser near the circulating water outlet, spreads along the entire length of the condenser before passing on its course down through the tubes where it is condensed, and finds its way by gravity to the air pump as condensed water, air, and noncondensible vapors.

The condenser shell, water chamber, and covers, are cast iron; the tubes are seamless drawn brass, and are secured at each end into Muntz metal tube plates by means of brass screw glands packed with corset lace packing. The tubes are free to expand and contract, but are held from getting out of place endwise by a shoulder in the screw glands. Where the tubes are long they rest in a support plate placed midway in their length. In all cases they are relieved from any impact of incoming steam by a baffle plate placed opposite the exhaust steam inlet. The condenser can be opened up and inspected without disconnecting any of the pipe connections.

The steam cylinder is of the standard Cameron type, with no outside valve gear, and makes its full stroke every time. The steam cylinder heads are removable without disconnecting any of the other parts. Both pump cylinders are brass lined and are fitted with brass pistons arranged for fibrous packing. The piston rods are of Tobin bronze and separate at the steam piston. The valve system in both air and water cylinders is of the usual Cameron arrangement. By removing the cover at each end of the cylinder every valve is exposed to view. Each valve stem holds 2 valves with their springs one above the other, so that by simply unscrewing one plug and pulling out the stem both are released. The air and water cylinders are in the most accessible position for inspection and repairs, and the air piston and valves are submerged at all times.

The A. S. Cameron Steam Pump Works is prepared to build all sizes of surface condensers up to 1,500 hp., and can furnish condenser shells of sheet steel or copper where lightness is a factor; or pump ends of all brass if desired. Where there is not sufficient head room, the condenser may be placed alongside the pump, but in all cases it should be high enough for the condensed water to flow by gravity to the air pump.

To LIVE CONTENT with small means; to seek elegance rather than luxury, and refinement rather than fashion; to be worthy, not respectable; and wealthy, not rich; to study hard, think quietly, talk gently, act frankly; to listen to stars and birds, to babes and sages, with open heart; to bear all cheerfully, do all bravely, await occasions, hurry never; in a word, let the spiritual, unbidden and unconscious, grow up through the common. This is to be my symphony.—William Henry Channing.

"DON'T GET DISCOURAGED. It is often the last key on the bunch that opens the lock."

NEWS NOTES

AT A RECENT DIRECTORS' MEETING of the New York Steam Co. George S. Beith, Jr., was elected secretary of the company to fill the vacancy caused by the death of B. F. Seadler.

JOHN P. COSGRO, who has for a number of years past traveled extensively in the southwestern part of the United States and northern Mexico, has been appointed district manager of the Allis-Chalmers Co., with offices in the El Paso and Southwestern Building, El Paso, Texas. Mr. Cosgro has had extensive experience in the West, with the Union Iron Works, of San Francisco, the Anaconda Copper Mining Co., and the Allis-Chalmers Co., and understands the various lines of industrial apparatus such as ore crushing, cement making and sawmill machinery.

MRS. F. A. W. MCINTOSH, formerly advertising manager of the Buffalo Forge Co., has opened an office at 103 Anderson Place, Buffalo, where she will engage in preparation and printing of advertising literature.

ON FEBRUARY 17TH the U. S. Civil Service Commission will hold examination to fill a vacancy in the position of Engineer in the Indian service at Ft. Berthold, N. Dak., and other vacancies, as they may occur. The salary is $720 a year and varies in the different posts from $480 up to $1,000. Examination is given in steam engineering, electrical engineering, heating, refrigeration, gas and gasoline engines and hydraulics. Application should be made to the U. S. Civil Service Commission, Washington, D. C., on form 1093, to be secured from the commission.

FOLLOWING ITS ANNUAL CUSTOM, the Crane Co. of Chicago, Ill., distributed to its 6,000 employes, gifts amounting to $340,000 at Christmas time. Accompanying this gift was a handsome photogravure, 10 by 12 in., of R. T. Crane, the founder of the company.

The officers elected for the coming year are: R. T. Crane, president; C. R. Crane, first vice-president; R. T. Crane, Jr., second vice-president; R. T. Crane, III, third vice-president; A. F. Bennett, secretary; J. B. Berryman, assistant secretary; A. B. MacGill, treasurer; R. B. Stiles, assistant treasurer.

On the board of directors besides the officers are Messrs. C. A. Olson, J. C. Gilgore, and W. W. Doolittle.

THE ANNUAL MEETING of the National Gas and Gasoline Engine Trades Association will be held at the Auditorium Hotel, Chicago, beginning February 9th.

THE AMERICAN BLOWER CO. has consolidated with the Sirocco Engineering Co., of New York, and the business will hereafter be transacted under the name American Blower Co., with main offices at Detroit. Both the Sirocco factory at Troy, N. Y., and the American factory at Detroit will be run to full capacity, the American plant having recently been enlarged by the purchase of the complete foundry and plant formerly operated by the Northwestern Foundry & Supply Co. The Sirocco fan was the invention of S. C. Davidson, of Belfast, Ireland, and was first designed for furnishing a draft for the drying of tea leaves. The distinguishing features are in the blast wheel or runner, which is of drum form with a large inlet chamber surrounded by numerous long and narrow blades curved forward instead of backward. This results in a discharge 4 times the volume of air of the ordinary steel blade fan for a given size of wheel, and for a given discharge the wheel is about half the diameter of the fan type and occupies about half the space. Mr. Davidson is interested in the new consolidation, the officers of which are: President, James Inglis, who has been president of the American Blower Co.; vice-president, Wm. C. Redfield, who has been president of the Sirocco Engineering Co.; treasurer, Chas. H. Gifford, who until a year ago was general manager of the B. F. Sturtevant Co.; secretary, Mr. Still, formerly chief engineer of the American Blower Co.

IN A TEST MADE LAST FALL by the Under-Feed Stoker Co., Limited, of London, on the boilers of the S. S. Corinthian, by Mr. Martin, chief engineer, and J. F. Blair for the Under-Feed Stoker Co., some interesting results were obtained. Durham unscreened coal was used under the boilers, of which one was a Morrison marine type and the other a Scotch marine. The grate surface was 55 sq. ft., the water heating surface 2152 sq. ft., steam pressure carried 165 lb. with 1⅛-in. draft. Feed water was at 195 deg. and the flue gas temperature for the hand-fired test was 482 deg. and for the stoker test 420 degrees. The hand-fired test was run on the 25th of August and the stoker fired on the 10th of December. It was found that with hand firing the evaporation per pound of coal from and at 212 deg. was 9.08 lb. of water and for the stoker firing 10.48 lb. Assuming the heat value of the coal as 12,500 B. t. u. per pound, this gave as efficiencies 70 per cent for the hand-fired test and 81 per cent for the stoker-fired.

REPAIRS OF POWER PLANTS are always of interest and one of the most difficult of these is the stopping of leaks due either to cracks in castings or to bad joints in piping. Smooth-On cement is one of the greatest helps in repairing such defects and the repairs that have been made by its use are frequently of great interest. If those who have made such repairs and can do so will furnish us good photographs of the jobs as completed, we shall be glad to pay for the cost of having the photographs taken and to pay such engineers for their trouble in getting this done for us. Communications may be sent either to Practical Engineer or direct to Smooth-On Mfg. Co., 572 Communipaw Ave., Jersey City, N. J.

THE DEATH IS ANNOUNCED, on Jan. 2, of Frank L. Thorpe, who for 25 yrs. has been the leading salesman of Geo. B. Carpenter & Co., and who is characterized by his associates as one of their most honored friends, a man of great sweetness of character and merchant of unusual ability.

DURING DECEMBER AND JANUARY MEETINGS have been held in Chicago to perfect the organization of the Internal Combustion Engineers' Association. As stated in its constitution and by-laws, the object of this association is to advance in every possible legitimate manner the interests of Internal Combustion Engineers, which term is meant to include operating engineers, superintendents, erecting engineers, designing engineers, and consulting engineers, who are actively concerned with combustion engines. As outlined in an address before the association by its treasurer, I. J. Babcock, activities to be taken up are, helping the best man to get the job, helping the best employers to get the best man, helping owners and operators to get more reliable and efficient service from their equipment, helping manufacturers towards greater uniformity in detail, design and workmanship and towards a higher average excellence in output.

These objects are to be accomplished by keeping lists of employers and members, by getting the reports on the causes of shutdowns and delays in starting up, by getting reports and records in regard to operating, efficiency and cost, by making reports on the reasonable results from plants and determining where the difficulties, if any,

lie, and by the conduct of experiments and investigations by maintaining a library, by meetings for lecturers, papers and discussions and by investigations of apparatus on the market to determine which is the best. The organization is planned to consist of grand divisions, such as would correspond to United States, Canada, Mexico, etc., divisions corresponding to Illinois, Province of Ontario, etc., and sub-divisions such as Chicago, New York, Montreal, etc.

The officers of the parent association are: H. R. Linn, of Postel & Linn, president; I. J. Bent, vice-president; I. J. Babcock, treasurer; Walter A. Sittig, secretary.

ON OCT. 28 AN ACCIDENT OCCURRED in the Municipal Lighting Plant of the City of Frankfort, Ind., by which the engine and generator being operated there, were wrecked, necessitating the immediate installation of a new unit. On the following morning, in response to a telegram, a sales engineer of the Allis-Chalmers Co. was on the ground and had submitted a proposal for a steam turbine and generator of 500 kw. capacity to operate at 3600 r. p. m. and delivery 2-phase 60-cycle current at a terminal pressure of 2300 volts. After meeting several shop difficulties, the apparatus was expressed on Nov. 3 in a special automobile car from the West Allis works of the company, near Milwaukee, arriving in Frankfort early the following morning. Four days later the unit had been completely installed and connected to its auxiliaries. During that day the generator coils were baked out, as is necessary to be done in all cases before a machine can be started, and on the following morning, Nov. 8, the unit was in regular operation and carrying the station load precisely 13 days from the time the original engine was wrecked. This is a remarkable showing in the rapidity with which this company is able to handle its orders and the fact that the apparatus is now running very satisfactorily speaks highly for the company.

THE AMERICAN BLOWER CO. just before the holidays held a most enjoyable reunion of its employes, at which an address was made by James Inglis, president of the company, extending greetings and expressing the satisfaction of the management at the cordial relations between the company and the men, in which there has been no break during more than a quarter of a century. To cement this friendship the company distributed to each of the employes one dollar as a gratuity, with an additional dollar for each year of continuous employment.

THE AMERICAN STEAM GAUGE & VALVE MFG. CO. announces that John B. Guthrie is the sole representative of that company in the Pittsburg district and that his offices are located in the Columbia Bank Building, Fourth Ave. and Wood St., Pittsburg, Pa.

LEWIS INSTITUTE, of Chicago, Ill., has arranged for evening courses, beginning Jan. 4, in engineering, covering electrical, steam and structural; in mechanical arts covering drawing, cabinet and pattern making, advance machine work and machine tool work; in mathematics covering geometry, algebra, trigonometry, accounting and arithmetic, and in chemistry and domestic economy, including cookery, sewing and millinery; in elementary and advance English, and in special subjects covering English history, physical culture, pottery and arts and crafts. A special departure of the Institute has been the arrangement with the Chicago metal manufacturers whereby apprentices may take alternate weeks in the shop and at the Institute, thus covering a special course in physical science, machine sketching and drawing, English history and mathematics.

EDWARD C. BROWN, manager of the Hawaiian office of the Dearborn Drug & Chemical Works, at 42 Queen Street, Honolulu, is making an extensive oriental trip of 3 or 4 mo., during which he will visit Japan, the important sea coast cities of China, Australia, the Philippines, Java and other important islands in the Pacific Ocean.

Mr. Brown has most successfully handled the Dearborn Company's business in the Hawaiian Islands since that department was opened, some 10 yr. ago.

THE SOUTHERN BRANCH OF THE AMERICAN STEAM GAUGE & VALVE MANUFACTURING CO., for several years located in the Equitable Bldg., Atlanta, Ga., has removed its office to 524-525 Candler Bldg., of that city.

CATALOG NOTES

SOME REASONS WHY is the title name given to a booklet issued by the Otto Gas Engine Works, of Philadelphia. On reading further it is discovered that these are reasons why Otto engines are and should be popular, and the descriptions and illustrations of the construction of the engine put forth interesting and instructive facts which go to prove the statement.

AN INTERESTING BOOKLET entitled "From Portland to Portland," issued by the Goulds Manufacturing Co., of Seneca Falls, N. Y., tells some of the work that has been done by the products of the concern.

INDUSTRIAL PROGRESS, issued at 330 Clinton St., Milwaukee, Wis., is a new publication dealing with power plants and power plant apparatus. In the first issue, which is for January, 1909, the hydraulic plant at Duluth. Minn., which is designed to develop 200,000 hp., is described, the big blast furnace gas engine plant and steel works at Gary, Ind., the gas engine plant of the Milwaukee & Northern Railway, and special machinery is treated in articles describing the use of the steam turbine in various industries, the use of power in cement mills, compound Corliss engines, and the machinery used in coal and coke operations. It is a handsome publication, 8 by 10.5 in. and will be enjoyed by those who read it.

FINE ARTS AND MECHANIC ARTS cannot be classed in the same group, but the use of one to advertise the other is accomplished in a highly artistic calendar sent by the Ashton Valve Co., of Boston, advertising its high grade pop safety valves and steam gages.

THE PENNSYLVANIA FLEXIBLE METALLIC TUBING CO., of Philadelphia, has set a standard in the manufacture of products in its lines and is calling the attention of its customers and friends to this fact by distributing calendars which are of an unique design, being a standard upon which a small copper card case containing the calendar cards is hung.

QUAKER CITY RUBBER CO. is making a specialty of high grade rubber pump valves for condenser pumps for hot water and for gritty and oily water. A leaflet describing the different kinds and the service for which they are suited is gotten out by the company.

STEPHENSON MFG. CO., of Albany, N. Y., sends us its January calendar, which carries a 3-color reproduction of a painting by Manning.

THE WESTINGHOUSE DIARY FOR 1909, like all Westinghouse publications, is worth while having. It is

a memorandum diary for the entire year, with maps of the United States and possessions, a large amount of information in regard to electrical machinery, electrical wiring, steam turbines and their performance, storage batteries, condenser performance, incandescent lamps, transmission chain, and other data of more general nature. It is finely bound in leather and, besides the daily memoranda space, has the complete yearly calendars for 1909 and 1910.

SCHAEFFER & BUDENBERG, of Brooklyn, N. Y., in a pamphlet just received, describes its Durax glasses for water gages, which are made with a light blue stripe so arranged that it appears wider in that part of the gage glass where the water is standing than it does above where the steam is. This is, of course, a great convenience in all places, and particularly where the gage glass is difficult to see.

THE LAGONDA MANUFACTURING CO. is distributing an interesting booklet of 24 pages on The Scale Question. The booklet gives numerous facts about steam power plant economy and protection and will interest all who own or have charge of boilers, economizers, condensers, etc.

Among the new Lagonda products described therein is the Weinland Air Driven Wing Head Cleaner. This machine is a miniature rotary engine which goes into the tube and rotates the cleaning head in much the same manner as a turbine does, but is more powerful. The booklet will be sent to all who write to the Lagonda Manufacturing Co., Springfield, Ohio.

A NEW DEPARTURE for engineering associations is found in sets of lantern slides gotten out by Rand, McNally & Co., of Chicago, which will be found interesting and will give attractive evenings. There are 10 sets showing the development of: 1, The Steam Boiler; 2, The Steam Engine; 3, The Electric Generator; 4, The Electric Motor; 5, The Transformer; 6, The Induction Motor; 7, The Locomotive; 8, Smoke Abatement; 10, The Steam Turbine; Set No. 9 consists of slides relating to the work of Nicola Tesla. There are 8 to 10 slides in each set, the price being at the rate of $1 a slide. They are made up in either black or plain colors and of standard size for American use. When ordered singly there is a slight additional charge.

NATIONAL PUMPING MACHINERY, made by the National Steam Pump Co., of Upper Sandusky, Ohio, is finely described in Catalog No. 9 just issued. This shows the construction of the National pumps and gives illustrations of the different classes with tables showing the capacities and the amount of space occupied by the different sizes. The catalog is a handsome book of 128 pages and contains besides the list of pumps, descriptions of the National air compressors and tables of hydraulic values.

DEAN BROTHERS STEAM PUMP WORKS, of Indianapolis, shows in a 3-color chart a fine illustration of its vertical air pump and jet condenser. This apparatus is double-acting, occupies but little floor space, has a water sealed piston rod and an adjustable stroke, while all valves are placed so as to be accessible without disturbing any part of the pump.

GOULDS SPRAYER AND PUMP, manufactured by the Goulds Manufacturing Co., of Seneca Falls, N. Y., is fully described in a pocket catalog which shows the applications of the device and the details of its operation, and particularly of the Mistry Junior nozzle. This apparatus will throw a liquid spray to cover any surface which it is desired to have covered with a minimum of work and a maximum of efficiency.

WILLIAMS MAGAZINE for January, which is published by the D. T. Williams Valve Co., of Cincinnati, is a most readable booklet and well worth spending an hour over.

CONDENSERS is the title of a new catalog issued by the Mesta Machine Co., of Pittsburg, describing the Helander barometric condenser, which has a number of interesting features. Copy can be had by writing.

COCHRANE SEPARATOR TALKS is the title of a convenient booklet issued by the Harrison Safety Boiler Works, of Philadelphia, in which the advantages of Cochrane separators for removing the moisture from steam and the oil and moisture from exhaust steam are fully explained. The booklet gives also sizes and dimension tables for the different forms of Cochrane separators.

LUBRICATION OF MACHINERY BEARINGS is an important item in any power plant and is almost always of importance to the engineer, as he is usually burdened with the duty of attending to this matter. In a pleasing booklet issued by the Philadelphia Lubricator & Mfg. Co., of Philadelphia, is explained how absolute satisfaction may be secured in the lubrication of bearings with a great saving in labor and with 50 per cent saving in the grease used. The booklet can be had on application to the above company.

SMOOTH-ON INSTRUCTION BOOK contains a lot of hints which the engineer can apply to his everyday work about the plant. It gives not only the regular uses for Smooth-On cements, but a lot of special repairs which have been successfully accomplished and which without the use of this cement would have been difficult and expensive. It shows how to repair cracks in piping, in cylinders, in furnaces; to make joints for water jackets and for gaskets. It shows also how well Smooth-On stands up under fire and how the material may be used in the tape form, for making screw thread joints and for packing. The value of this booklet is shown by the fact that it is now running in the 7th edition, 6 editions having been taken up by interested engineers; 10,000 copies were exhausted within a month, but a new 25,000 are ready to send to all who desire one.

WE ARE JUST IN RECEIPT of a handsome catalogue compiled by The Deming Co. of Salem, Ohio, giving full details of their spray pumps, nozzles and appliances. The catalogue contains a very complete 12-page spraying chart, also gives sectional and detail views of several of the pumps, and illustrates many of them in action. It is printed in 2 colors with shaded illustrations, making a very fine appearance. The catalogue states that these spray pumps can be used to great advantage for whitewashing in mills, factories, warehouses, etc. The Deming Co. also manufactures a very complete line of hand and windmill pumps, hydraulic rams, and triplex and deep well power pumps for various duties and for operation by any power. Interesting literature will be sent to any parties desiring information on any Deming pumps, on reecipt of request.

THOSE INTERESTED IN STREET ILLUMINATION will be also interested in the General Electric Co.'s bulletin No. 4620, describing its Series Luminous Arc Rectifier System, which forms a striking contrast to the old open arc system of lighting. The bulletin goes more or less into details and describes the various pieces of apparatus used in connection with the system, including arc lamp hangers and cut-outs, constant current transformers, mercury arc rectifier tube, switches for use in connection with the system, etc. It contains, also, dimensions and connection diagrams.

ANY ENGINEERS WHO HAVE not received the

big office calendar of the Dearborn Drug & Chemical Works have missed a good thing and should write a postal to the Dearborn people asking for one.

TRADE NOTES

THE U. S. FLEXIBLE METALLIC TUBING CO., whose San Francisco establishment has been temporarily located at the northeast corner of Beale and Mission streets, has now moved to its permanent location, 63-65 Main street, San Francisco, Cal. The new quarters will enable the company to care for the wants of its many patrons, insuring promptness and exactness in giving attention to the requirements of its many friends. The new establishment will afford considerable space required to handle the long lengths of metal hose for installing connections and the testing of same, as the Metallic Tubing Co. will not allow metal hose to leave the establishment without being subjected to a thorough test. The new quarters will also enable the tubing company to carry a large stock of metal hose and so enable it to meet all requirements. A cordial invitation is extended to all friends to call at the new establishment, where they will find the various styles of hose carried in stock and extend all information possible in regard to flexible metallic tubing.

THROUGH THE OFFICE of Chas. T. Main, of Boston, the designing engineer, the Pacific Mills of Lawrence, Mass., has recently placed orders for additional power house equipment as follows: With the Allis-Chalmers Co. for a steam turbine with turbo-jet condenser and a generator of 3,250 kw. capacity, and an additional exciter and switchboard apparatus. With the Bigelow Co. for 12 additional horizontal return tubular boilers, of practically the same size as those contained in the first installation. These boilers will be supplied with superheaters.

The buildings are of sufficient size to contain all of this new apparatus, which completes the unit of station which has been planned for and built.

Another chimney will be built of the same size as the one recently erected, namely, 200 ft. high and 9 ft. diameter inside the core.

A NEW SHEET PACKING called the Garlock Style No. 900 is made of a peculiar mottled fiber that is extremely tough. This has a tensile strength of over 6,000 lb. a square inch, and the material separates readily from iron surface so that the packing is not destroyed when opening a joint. In gasket form this is known as Style No. 950.

WRITING TO JOHN F. O'NEIL, of New Orleans, La., in reply to an inquiry from him, H. J. Landry, Manager of the Longbridge, La., Cotton Oil Co., states in regard to an engine which has been in use in his mill:

"In answer wish to say that the engine we have is an 18 by 42-in. Corliss of the Bates make and that it has been operated for the past 3 seasons with perfect satisfaction. The engine has given us good service and has been satisfactory, both as to economy and durability, the engine being in as good shape today as the day it was installed.

"We will be pleased to give you any further information you may want, and would not hesitate to recommend this engine to any one desiring a good, substantial engine, and one combining with its durability, economy and efficiency."

AMONG RECENT SALES OF "Swartwout" Specialties are the following: Owosso & Corunna Electric Co., Owosso, Mich., 3 steam separators; Rawlins Electric Lt. & Fuel Co., Rawlins, Wy., cast-iron exhaust head; Orono Pulp & Paper Co., Basin Mills, Me., cast-iron exhaust head; Mayflower School, Cleveland, O., cast-iron exhaust head, oil separator and steam separator; Cleveland Plain Dealer, Cleveland, O., 12-in. cast-iron exhaust head; Quaker Oats Co., Akron, O., 7-in. horizontal steam separator; Moller & Schumann Co., New York, N. Y., cast-iron exhaust head; Norfolk Wire Cloth & Wire Fence Mfg. Co., Norfolk, Va., 2 cast-iron exhaust heads; Girard Iron Co., Girard, O., 12-in. cast-iron exhaust head, 8-in. and 6-in. vertical steam separator; Sheridan Electric Lt. & Power Co., Sheridan, Wyo., 12-in. cast-iron exhaust head; Chicago Union Transfer Railway Co., Clearing, Ill., 14-in. cast-iron exhaust head; Crabtree Coal Mining Co., Ilsley, Ky., 10-in. cast-iron exhaust head; Ohio Seamless Tube Co., Shelby, O., 9 72-in. gravity closing ventilators; Virginia-Carolina Chemical Co., Pinner's Point, Va., 12 36-in. gravity closing ventilators; Western Packing & Provision Co., Chicago, Ill., 10-in. cast-iron exhaust head.

THE DEARBORN DRUG & CHEMICAL WORKS report that the general business of the company for the last 6 months of 1908 was larger than for any other 6 mo. in their history, indicating the quick return of prosperous business conditions. The percentage of increase the past few months, and especially for January, in the eastern department of the company, is particularly gratifying. Grant W. Spear, vice-president and eastern manager, at the general eastern offices, 299 Broadway, New York, who has been for years vice-president of the Dearborn Company at Chicago, ably assisted by Herbert E. Stone, as general sales manager; P. H. Hogan, manager of the Boston office, and Paul T. Payne, manager of the Philadelphia office, with P. G. Jones as special representative in the Philadelphia district, together with such popular and able representatives out of the New York office as Messrs. McConnaughy, Mitchell, etc., constitute a most effective organization which is an assurance of the high grade manner in which the affairs of the Dearborn Company will be handled in the Atlantic Coast states.

THE MINNEAPOLIS STEEL & MACHINERY CO. has been given the contract for furnishing the new engine for elevator D of the Consolidated Elevator Co., Duluth, Minn. They will install a 26 and 52 by 48-in. vertical tandem compound Twin City Corliss engine with flywheel 16 feet in diameter, grooved for 22 2-in. ropes. The entire engine will be completed by April.

WATCH FOBS which have been distributed by the Pilley Packing & Flue Brush Mfg. Co., St. Louis, have proved extremely popular, and they ought to, for they are of a handsome and durable design. The company has ordered a stock of these and will be glad to mail one to any engineer on request.

A NEW METHOD for grinding glass has been discovered by the Onward Manufacturing Co., which has factories at Menasha, Wis., and Berlin, Ont., and manufactures the Onward Sliding Furniture Shoe, which takes the place of the wheel caster. This discovery is a grindstone made from ½ best Portland cement and ½ Silica sand. It must be thoroughly mixed and tamped even. The advantage of this stone is that when properly made there will be no hard and soft spots, and it will grind glass without scratching. The cost is about 10 per cent of the common grindstone. It has been used successfully for 1 year.

WANTED

"Positions Wanted" advertisements not exceeding 50 words for subscribers to Practical Engineer will be inserted twice free of charge. "Help Wanted" and special advertisements 25 cents a line.

POSITION

Experienced engineer, holding second-class Massachusetts license wants a position. Address John E. Ware, 45 Broad St., Salem, Mass. 13-2

POSITION

By young married man in some large plant in Ohio or adjoining states. Have had several years' experience with steam engines. Can give reference. Address E. G. Merritt, Casstown, Ohio. 2-2

POSITION

Want a place as stationary engineer, either in factory or electric light plant. Nine years' experience. Can give references or come on trial. Address L. R. Smith, Box 433, Fairbury, Ill. 11-2

POSITION

By diamond drill operator, three years experience. Can set bits. Eight years in charge of engines and boilers. Would work in plant until vacancy in field. Address Box 90, care Practical Engineer. 11-2

POSITION

As engineer in some large or medium size plant by sober, industrious worker. Employed at present, but prefer the south or southwest. Address E. A. Landis, 1642 W. Monument Ave., Dayton, O. 2-2

POSITION

As assistant engineer or fireman. Have had six years' experience and have nearly completed engineer's course in I. C. S. Can furnish references or come on trial. Address F. F. Ninman, Belle Plaine, Wis. 2-2

POSITION

At firing by young man 19. Some experience, strictly sober, handy at steam fitting. Prefer small plant in Milwaukee or Chicago, but will go anywhere. Give full particulars first letter. Address Box 97, Practical Engineer. 2-2

POSITION

As second-class engineer, oiler or helper in steam plant. Have second-class Minnesota license. Can give references, or would come on trial. Good, steady worker. Prefer Minnesota or Wisconsin. E. Pascoe, Box 116, Deerwood, Minn. 2-2

POSITION

As chief or second engineer, without firing, in a manufacturing or power plant. I am 38 years old, with family. Have had 16 years' engineering experience. Best of references; willing to locate anywhere. Address Box 91, Practical Engineer. 13-2

POSITION

By young man as oiler or helper in an engine room. Have finished the study of boilers in my I. C. S. steam engineering course. Age 19; no experience, no bad habits, good worker. Give full particulars. Address Wm. D. Myers, 369 East Union St., Circleville, Ohio. 13-2

POSITION

as second-class engineer in a stationary or electric light plant, or will take a job at firing, also in a Corliss engine shop. Have six years' experience with steam engines. Can give references or come on trial. Location not important. Hold second-class Minnesota license. Address Fred W. Dammann, Lock Box 200, Sanborn, Redwood county, Minn. 13-2

POSITION

Electrical engineer, first-class license, wishes to better his position. Technical training in university and experienced in ice making and refrigerating machinery. Strictly sober, 27 years old. Am looking for a permanent position with a good firm. Best references or recommendations. H. M. Warner, Lock Drawer Box 5, Station F, Cleveland, O. 2-2

POSITION

By electrician with twelve years experience with all makes of motors, generators, arc lamps and meters, rebuilding city light and power plant inside and outside. Prefer assistant superintendent of small light and power plant. Am a business getter for commercial lighting. Best of references. Address Otto Von Humrick, 310 Gibson St., Detroit, Mich. 11-2

POSITION

General superintendent and works manager will be at liberty February 1st. Ten years with high-class concerns in Middle West; experienced in foundry, machine, sheet metal, forge and woodworking lines, with up-to-date ideas of shop organization and practice on economical production. Address "Superintendent," 1105 N. Alabama Street, Indianapolis, Ind.

POSITION

By young man as assistant or oiler in engine room. Have finished complete steam engineering course of I. C. S. as far as engine management. Age 22, sober and industrious. No experience. Give full particulars. Address Le Roy Scott, Box 360 East Jordan, Mich. 2-2

POSITION

Engineer with fifteen years' experience with steam plants for office buildings, hotels, department stores and waterworks desires change of situation. Graduate of International Correspondence Schools. Age 35; highest class references. Address R. Cederblom, Box 757, Gary Ind. 2-2

POSITION

As chief engineer, experienced with all kinds of engines, A. C. and D. C. generators, motors and switch boards, boilers and pumps and all apparatus connected with a plant. I can get results and furnish best of references. Now employed, but want to change. Address Box 89, Practical Engineer. 11-2

POSITION

Engineer now employed by large manufacturing company wishes to make change. Experienced on all types of modern boilers and engines, A. C. and D. C. generators, gas engines and storage batteries. Recommendation from present employer. Prefer to have full charge and be responsible for economical operation of plant. Address Box 92, Practical Engineer 13-2

SALESMAN

In every large city, a salesman or engineer with an acquaintance in power plants, to handle a new lubricant which is guaranteed to save from 40 to 50 per cent. in oil consumption. Free from all injurious matter and will be placed on trial to prove its merit. To the right man a good income is assured and a future business that will prove both pleasant and profitable. Address Box 96, Practical Engineer. 2-1

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To introduce our New Commercial and Statisical State Chart for office and general use. The work is congenial and profitable, the earnings being according to your ability. A thorough training is given before the work is started. Rand, McNally & Co., Chicago, Ill. 10-5

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A high grade salesman with experience in selling machinery and equipment in the power plant field. Must have a record showing ability to develop and close sales with big industrial establishments, consulting engineers and architects. Preference will be given to an ex-Allis-Chalmers or Westinghouse man, but consideration will be given all applicants. An excellent opportunity for the right man. Address Box 94, Practical Engineer.

REPRESENTATION

A hustling manufacturing concern of the Middle West, building a high grade line of steam and oil separators and steam traps, desires representation in the larger cities, both east and west. An opportunity for a live contracting engineer whose present line does not conflict with our products. Address Box 93, Practical Engineer. 2-2

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Must be in good repair, ready to run and the price made attractive. Size, 8x20 inches, or smaller. Address Box 95, Practical Engineer, 355 Dearborn St., Chicago.

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The new revised edition of the Modern Engineer's Hand Book. A $2.50 Book by mail on receipt of 50 cents. Be quick. Address, W. H. Ermentrout, 514 Elm Street, Reading, Pa. 4 tf

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